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TRANSACTIONS

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THE AMERICAN ASSOCIATION OF GENITO-URINARY SURGEONS

FIRST DAY, MAY 26, 1932

CARBUNCLE OF THE KIDNEY

WITH REPORT OF TWO CASES OF BILATERAL INVOLVEMENT

FRANK S. PATCH, M.D., and R. GRANT REID, M.D. (by invitation)

From the Departments of Urology and Pathology, The Montreal General Hospital, Montreal, Canada

Since Israel made his classic contribution to the subject of renal carbuncle, in 1891, numerous articles have been published on it, and many new problems in diagnosis and therapy have been discussed. And from these contributions, the clinical and pathologic entity of renal carbuncle seems to have been clearly established.

Renal carbuncle, so-called from its gross resemblance to carbuncle seen in other parts of the body, is a typical disease of the kidney, developing secondarily to a suppurative focus elsewhere in the body. Usually the infective organism is a staphylococcus, which originates very frequently in a furuncle or carbuncle, or other infected peripheral focus, and is brought to the kidney by the blood stream. The symptoms develop, as a rule, rather gradually. There may be high fever, continuous, remittent or intermittent. Urinary symptoms may be absent, and pyuria may be absent or scanty. At times, fever and general signs of lassitude and headache, may be the only signs. Usually there are dull pains in the affected side. Frequently there is tenderness in the loin, with occasionally muscular resistance. The kidney may be palpated, and its swollen and tender character made out. Perinephritic abscess frequently complicates the intra-renal condition. Leukocytosis is usually present. In many cases, there is difficulty in differentiating the condition from suppurative nephritis, or renal abscess, or the early stages of a perinephritis.

A renal carbuncle is a typical lesion. It is a sharply outlined area composed of many small, round, discrete, suppurative foci,

separated by the remains of renal tissue. In their earliest stages they have a honeycombed appearance. Their resemblance to tumor is, at times, very striking.

As the reported cases do not number more than sixty, there need be no excuse for reporting two additional cases, which were

Fig. 1. Case 1. Right kidney, sectioned, showing carbuncles. Liver adherent, also showing a carbuncle.

proven by autopsy. Inasmuch as they both present what Pleschner states to be the extraordinarily rare fact of bilateral involvement, there is an added inducement. Apart from these two cases, the second case of Kretschmer, the two cases of Stuckey and Rjasanzewa, and a doubtful one reported by Reschke, are the only

instances known to us. The patient of Reschke died of general peritonitis resulting from a perforation of a perinephritic abscess into the peritoneal cavity. The autopsy revealed a right renal carbuncle, and "an abscess" of the left kidney.

In addition, two cases of unilateral perinephritic abscess which recovered after drainage, in which a diagnosis of renal carbuncle is probably warranted, are reported.

Our two fatal cases of bilateral involvement are given in detail herewith.

Case 1.—A male, laborer, aged thirty-four, was admitted to the urological service of The Montreal General Hospital, January 28, 1930, complaining of perineal pain and increased frequency of micturition. On January 17 he had six teeth extracted, which were stated to be abscessed. Two days later, severe headache developed and he was dizzy and feverish. On the twentieth, he noted a severe aching pain in the perineum, worse on walking or sitting down. At the same time there was noted an increased frequency of urination, by day, every two hours, and four to five times a night, and also a frequent desire to defecate. There had been no previous venereal disease. The symptoms increased in severity, and hospital admission was secured on the twenty-eighth. His general condition was good. The temperature was 99, and the pulse 96. The only signs were a swollen prostate on the left side, and some purulent urethral discharge. The urine contained a few pus cells. On the day following admission the temperature rose to 104, but quickly fell to 99-99.5. The prostatic swelling seemed to be evacuating itself per urethram. A culture of Staphylococcus aureus was obtained from the pus. The symptoms subsided, the prostatic swelling decreased, and the patient, feeling quite well, was discharged on February 5, for outdoor treatment.

The symptoms, however, quickly returned, and the patient had to be re-admitted on February 9. The prostate was more swollen than before, urethral discharge was present, the urine was purulent and the temperature 101. The prostate was drained on the thirteenth by perineal incision. Culture of the pus showed Staphylococcus aureus. The cavity drained indifferently well and on March 28 it was re-explored and drainage re-established. The temperature continued to show daily elevations to 101-102. The urine showed a few pus cells. There were no symptoms referable to the kidneys. On April 8, there was first noticed a right renal mass, the size of an orange, ballottable, but without tenderness; the left kidney was also slightly enlarged. No pain or tenderness was felt on either side. Blood transfusion was made, April 10. Blood culture on this date was positive—Staphylococcus aureus. April 14, cystoscopy was performed; bladder contents were turbid with pus. The right kidney urine was very purulent and

drained with difficulty through the catheter, culture giving B. coli and Staphylococcus aureus. The left kidney contained a few pus cells. Inlying catheter drainage and pelvic lavage were tried. A tentative diagnosis of bilateral renal infection, with right pyonephrosis, was made. Pyelograms were not made.

Following a blood transfusion, the right kidney was explored on April 22, under sodium amytal anesthesia. The mass was still cir-

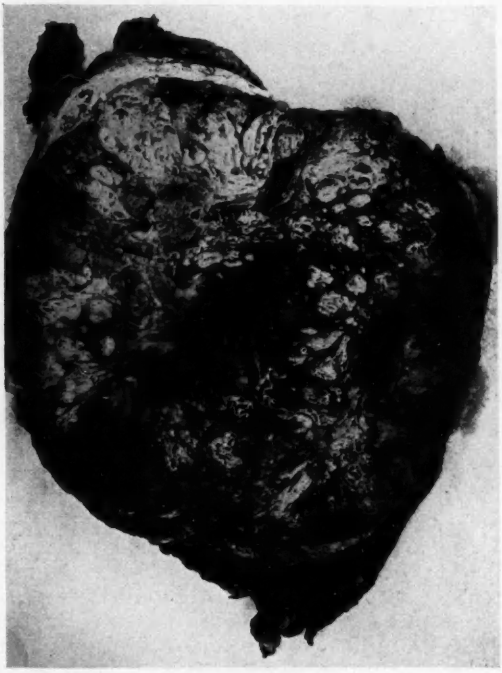

Fig. 2. Case 2. Right kidney, sectioned, showing diffusely distributed carbuncles.

cumscribed and quite free from tenderness, and yet, on sectioning the muscles, a large pus cavity with edematous parietes was opened, and the pus evacuated. The kidney was not felt, and was not explored further. Culture gave Staphylococcus aureus. The cavity was drained with a tube. Slight improvement followed, but the temperature soon regained its "church steeple" character. The patient's general condition failed gradually. May 1—there is a note that "the patient com-

plains of no pain." May 8—"an indefinite swelling in the left loin." May 10—"a very obvious mass in the left kidney region." "No tenderness." On May 12 incision was made in the left loin under local anesthesia, and a fairly extensive pus cavity was entered and drained. A culture of the pus gave Staphylococcus aureus. On May 15, a blood transfusion was given. Slight improvement followed, but the septic character of the temperature was soon re-established, and the general condition gradually failed. An abscess was opened on the inside of the left knee on June 16. Death occurred on June 19 from asthenia. The urinalysis in the month preceding death had shown no amount of pus greater than 8-10 cells per high power field.

Postmortem (M.G.H. A-30-161).—Dr. L. J. Rhea has kindly furnished us with the following abstract of the protocol.

"The general findings at the postmortem were those commonly found in Staphylococcus aureus pyemia and are covered in the anatomical diagnosis below. Only the lesion in the right lobe of the liver and those in the kidneys will be described in detail.

"There were large bilateral surgically drained perinephritic abscesses. They contained thick purulent material. The largest amount of pus was about the posterior aspect of the kidneys. The perinephritic fat was firm and edematous.

"The right kidney weighed 350 grams and the left 300 grams. Both were similar in every respect, except their weight. Their external surfaces were bathed in a thick purulent material. The capsules were intact, were very tense and, in places, were adherent to the surrounding tissues. The upper pole of the right kidney was quite firmly united to the under surface of the right lobe of the liver.

"Longitudinal sections through the kidneys showed a very striking picture. Their surfaces were bathed in pus. They were swollen and their parenchyma extended beyond the incised capsules. The most striking lesions were round, quite sharply outlined acutely suppurative areas, from 2 to 5 cms. in diameter. They were numerous, most of them were in the superior half of the organs, and were separated by intact kidney substance. Each of them was composed of numerous small, round, purulent foci which were separated by the remains of kidney tissue. While these suppurative lesions were similar in their general character, they differed somewhat in detail. In the most recent ones, the small abscesses were discrete. In some of the others there was a tendency for the suppurative foci to become confluent. When the earlier lesions were carefully washed with running water and all the acute exudate removed, there was left an area which had the appearance of an empty honeycomb.

"Within the right lobe of the liver, near the superior border of the right kidney, there was a sharply outlined suppurative area 3 cms. in diameter. This area was composed of numerous pus pockets separated

Fig. 3. Case 3. Pyelogram made immediately previous to surgical drainage of perinephritic abscess.

Fig. 4. Case 3. Pyelogram made two weeks after surgical drainage of perinephritic abscess.

Fig. 5. Case 3. Pyelogram, thirty-nine days after surgical drainage of perinephritic abscess.

by liver tissue and was similar in every way to the carbuncles in the kidneys.

"The prostate was enlarged, hard and contained purulent exudate. Just posterior to this organ there was an abscess cavity which had been drained through the perineum.

"Microscopically the kidney lesions were those of acute suppuration and there were many Gram + cocci in the abscesses.

"Anatomical diagnoses:

Prostatic abscess drained through the perineum.
Pyemia (Staphylococcus aureus)
Carbuncle of the kidney (bilateral)
Bilateral perinephritic abscess, surgically drained
Carbuncle of the liver (right lobe)
Cystitis (acute)
Broncho-pneumonia (bilateral)
Acute purulent bronchitis (bilateral)
Multiple abscesses of the lung
Bilateral basal empyema
Ascites
Hydropericardium."

Case 2.—For permission to report this case, we are indebted to Dr. Campbell P. Howard, in whose service of The Montreal General Hospital the patient was treated.

A man, aged forty-four years, was admitted on November 2, 1931, complaining of abdominal pain, and weakness. He had been a patient in the same service from July 12 to July 31, 1931, suffering from catarrhal jaundice. During this admission, he had complained of a severe pain in the upper abdomen, worse on the left side. It ran up to the right shoulder, anteriorly and posteriorly. During this admission, the urine was entirely negative.

On September 6, while at work, he scratched his left shoulder with a nail and the wound became infected, requiring dressings at the Surgical Outdoor for three weeks. About October 1, he began to have pain in the right upper quadrant of the abdomen, radiating to the back, which gradually became worse. On October 20, he noted a cough with blood streaked sputum. On two occasions during the preceding month he had mild rigors.

On admission there was noted an icteroid tint to the scleræ, with some cyanosis of the lips and nailbeds. A bilateral broncho-pneumonia was diagnosed by Dr. Howard. The abdomen was markedly distended, with enlargement of the spleen. The liver could not be felt on account of the distention. There was tenderness on pressure in the right upper quadrant. There was a discharging wound on the left shoulder, with another abscess near it which contained pus, giving Staphylococcus aureus on culture. Urine contained bile and a few pus

cells. The patient was feverish, the temperature having a daily range from 99° F. to 102° F. Blood cultures taken on November 3 and 5 were positive for Staphylococcus aureus, and it was suggested by the visiting internist that the abdominal symptoms were due to an infective thrombosis of the portal vein. The patient's condition became progressively worse, and a culture of the sputum on November 9 showed Staphylococcus aureus. Albumin was present in the urine in all speci-

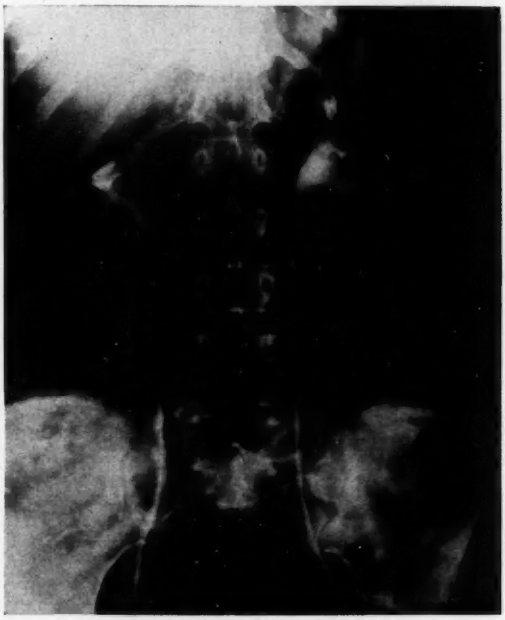

Fig. 6. Case 4. Pyelogram made previous to surgical drainage of perinephritic abscess.

mens examined after the first, but pus was present on only two occasions out of five, in an amount of 10-15 pus cells per high power field. The specimen three days prior to death showed 50 pus cells per high power field. The patient's jaundice gradually deepened, the abdominal distention became more marked, and he died on November 13.

Postmortem (M.G.H. A-31-237).—Dr. L. J. Rhea has furnished the following abstract of the protocol.

"Only the kidneys will be described. The lesions in the other organs and tissues are those commonly found in Staphylococcus aureus pyemia and require no detailed description.

"The left kidney, which weighed 620 grams, was, in places, bound to the surrounding tissue and was surrounded by a large abscess filled with purulent material which was continuous with a similar exudate that surrounded the left ureter, about which it extended down as far as the brim of the pelvis. The external surface of this kidney was irregular, due to protrusion of intrarenal acute suppurative lesions. The capsule covering some of these lesions had been destroyed in places, resulting in a direct communication between them and the perinephritic abscess.

"The cut surface of this kidney was bathed in a large amount of pale greenish pus. It had only a remote resemblance to kidney tissue. Even after the exudate was washed away the involvement was so extensive and so pronounced that the specimen did not even then resemble a kidney. The organ was enlarged in all diameters and throughout it were great numbers of suppurative areas. Most of these were round. They varied in size from 2 to 6 cms. in diameter, were separated by compressed kidney tissue and in general showed the same structure. They were composed of numerous, discrete to confluent, greenish yellow, purulent foci, which were, in a good many of the lesions, sharply demarcated. Large microscopic sections showed this especially well when projected as one would a lantern slide. Their structure was especially well shown when their contents had been removed by careful washing. There then remained an area which contained irregular spaces separated by remains of kidney tissue, the whole suggesting a sponge, or, even more than that, an empty honeycomb. The kidney pelvis was injected and contained pus. The right kidney weighed 570 grams. There was a large perinephritic abscess about it, and this organ on section was similar in every respect to the left one.

"Anatomical diagnoses:

Healing superficial area of infection, right shoulder
Pyemia (Staphylococcus aureus)
Carbuncle of the kidney (bilateral)
Perinephritic abscess (bilateral)
Acute suppurative peri-ureteritis (right)
Acute axillary abscess
Acute peritonitis
Acute empyema (bilateral)
Abscesses of the lungs
Acute broncho-pneumonia (bilateral)
Acute purulent bronchitis (bilateral)."

While we may have been dilatory, in the first case, in dealing radically with the prostatic abscess, the relative silence of the kidneys later, when undoubtedly involved, misled us entirely. The first renal signs were noted on April 8, and on the tenth the patient was pyemic, and any therapy more or less hopeless.

The presence of a carbuncle in the right lobe of the liver, the exact counterpart, apart from the difference in the surrounding tissues, of the renal carbuncles in this case, is worthy of special note, on account of its great rarity.

In considering the second case, it seems impossible to have made a diagnosis of renal carbuncle. The patient was pyemic, the abdomen was so distended that no localizing signs or symptoms could be elicited. The character of the pain on the right side was suggestive of gall-bladder disease, rather than of a renal or perirenal lesion. On the left side there were no localizing signs or symptoms. The urinary signs were so scanty as not to attract special attention. In the light of experience, a urologic study might have cleared up the diagnosis.

The occurrence of a renal abscess and a prostatic abscess is stated by von Lichtenberg to be a remarkable happening, which he ascribes to a special etiologic factor connecting the two organs, particularly as he has encountered six cases in which prostatic abscess was secondary to renal abscess, one of the cases being a renal carbuncle. In the pyemic condition of our patient, the obstruction offered by a swollen prostate would easily tend to lowered resistance of the kidneys and render their hematogenous infection all the easier.

The occurrence of bilateral perinephritic abscesses in both cases is somewhat unusual, though, from the autopsy findings, not so unexpected as the rarity of the reports would indicate. The occurrence of a perinephritic abscess following a renal carbuncle is not an unusual happening. So much so, Colmers and Lazarus are of the opinion that the reported cases of renal carbuncle would be more numerous if all perinephritic abscesses operated upon were more thoroughly explored, and the kidneys more minutely examined. While this may undoubtedly be true, one may well question the wisdom, clinically, of a too extended examination of the

kidney at the time an abscess is opened, on account of the greater exposure and manipulation required.

We have recently evacuated, by incision, a perinephritic abscess in which the diagnosis of renal carbuncle seemed warranted. In this case complete recovery followed conservative therapy. The case report is given herewith.

Case 3.—A youth of seventeen was admitted to one of the surgical services of The Montreal General Hospital on March 23, 1932, with a diagnosis of acute appendicitis. He gave a history of having been in bed for one week previous to March 18, suffering from furuncles on the neck. On that day he was seized suddenly with a sharp pain in the right loin, worse on moving, which radiated to the front of the abdomen. He vomited on several occasions. Five days later, he was brought to the hospital. The pain, a dull ache, had persisted from the onset. He had been constipated. No note was made of any urinary symptoms.

On admission the temperature was 102, the pulse 100. There was acute tenderness and resistance in the right lower quadrant, and in the right loin; no rebound pain. Rectally, there was tenderness on both sides. The white blood cell count was 13,500. Urinalysis was normal, except for a faint trace of albumin. There were signs of the boils on the back of the neck, though no acute infection was present. The patient was operated upon almost immediately, and a normal appendix was removed.

Within the first thirty-six hours after operation, the patient complained of pain and tenderness in the right loin. The tenderness was most marked in the right costo-muscular angle. Some resistance of the muscles was noted. X-rays for calculus were negative on the twenty-sixth. The urinalysis was normal on the twenty-fourth and the twenty-sixth, but on the twenty-eighth an occasional leukocyte, with a faint trace of albumin, was noted, and again on the thirtieth. On the twenty-ninth, the patient complained of increased frequency of urination. On the thirtieth, the urological service was called in consultation. By this time it was evident a perinephritic abscess was present, and based on the history, the slight urinary symptoms, a tentative diagnosis of renal carbuncle and perinephritic abscess was made. The white blood cell count was 22,800. Before operation on the thirty-first, a cystoscopy was done, and a right pyelogram made. The urines were normal in all respects, the flow being slightly less free from the right kidney. The pyelogram showed incomplete filling of the right lower calix, and slight upward displacement of the middle calix. Cultures were made from the ureteral specimens and were negative. The abscess was incised immediately following the cystoscopy, gas oxygen anesthesia being used. The abscess was situated about the upper pole of the kidney, on its posterior aspect. The kidney was not exposed. Drainage

was instituted. Culture of the pus gave Staphylococcus aureus. Following the operation, the temperature had a lower range, rising to 101, but from April 3 on, it rose to 103 daily. There was less discharge from the wound, as time went on. The urines remained pus-free. Cystoscopy was repeated on April 14. Normal urines were obtained. The pyelogram showed less signs of abnormality than the previous one. The middle calix was in normal position, and the lower calix showed less incomplete filling. On April 16, the wound sinus was explored with long dressing forceps, and dilated. Considerable pus was evacuated. Within forty-eight hours the temperature fell to 100, and in the course of the next fourteen days gradually fell to normal. Cystoscopy was done on May 9 and the pyelogram of the right kidney, which was then made, showed a normal kidney outline. At the date of writing, the patient is perfectly well.

COMMENT

While incontrovertible proof is lacking that we were dealing with a renal carbuncle in this case, there are many and reasonable grounds for believing that it was a renal carbuncle which evacuated its contents secondarily into the perinephritic abscess cavity. The pyelographic series would seem to justify our claim, and offers ocular demonstration of the recovery of the kidney.

The laparotomy which was performed on admission is not an unusual error, in cases of carbuncle of the kidney. Many of the reported cases were first operated upon by this route. Similarly, many cases were treated under a medical diagnosis of pyemia, typhoid fever, and other acute septic conditions, and, as in our second case, with no suspicions of a renal involvement.

The pyelogram in Case 3 reminded us of a patient whose pyelogram had long intrigued us and led us to review the case, and to conclude that we had failed to diagnose the real condition, which we now think was one of a renal carbuncle.

Case 4.—A maiden lady of fifty-three was admitted to the service of Dr. H. M. Elder, February 22, 1927, complaining of loss of weight and strength, and of thirst. In October, 1926, she had a carbuncle on the left temple, which received treatment for two months. From that time she had not felt well, and from January 1, 1927, had been steadily losing weight and strength. On admission, she had a temperature of 102 degrees. She stated she had a feeling as of a mass in the right loin. Tenderness was noted in the epigastrium, in the right upper quadrant, and in the right costo-muscular angle. Resistance was noted on the right side of the abdomen. There was a sense of an indefinite mass there, but palpation was difficult on account of the tenderness.

The leukocyte count was 25,000. The urine showed a faint trace of albumin, but no pus. The abdomen was opened on February 23, 1927, by Dr. Elder. The intraperitoneal organs were normal, but in the right kidney region there was a "large, hard, lobulated mass." This mass was adherent to the under surface of the liver, and to the appendix. The mass was described as being "hard and rubbery," and did not give the impression of containing fluid. The appendix was removed and an incision made in the parietal peritoneum posteriorly. The kidney did not feel normal to the touch, but felt hard and fibrosed.

The patient appeared improved after the operation and the temperature for the first two days was only slightly elevated. On the third day, however, it rose to 100°, the rise being ascribed to a right-sided saphenous vein phlebitis. The urine was negative until March 14, when a catheter specimen revealed 30-40 pus cells per high power field. On March 15, one of us was called in consultation. The temperature was 102°, and there was marked tenderness in the costo-muscular angle. A cystoscopic examination was made on the sixteenth. The bladder was normal. Both ureters were catheterized. The right specimen was pale and cloudy, the left clear and of normal color. Cultures were not made. Phthalein was injected intravenously, with appearance on the left side in four minutes; on the right, only after thirteen minutes, and in much less intensity than on the left. Pyelography showed a normal left kidney. On the right side, the lower calices were only partly filled and apparently displaced upwards and, to quote the report, the finding was "strongly suggestive of tumor."

Operation was performed on March 19, through a right lumbar incision. Edema was noted in the subcutaneous fat and in the muscles at the upper end of the incision. On cutting through the muscles, a hard mass was revealed, running from under the ribs down to the iliac crest. The mass was firmly adherent to the parietes and the peritoneum. It was almost cartilaginous in character. Explored by cutting into it, normal kidney could be felt at a depth of 1.5 inches. This fibrosed fatty capsule was dissected intracapsularly to both poles of the kidney. In so doing, a small quantity of pus was liberated. This cavity was drained and the wound closed over it. The wound drained pus, for some time, and on her discharge one month later there was still a small sinus. Her temperature remained elevated, daily to 101 degrees. Her general condition, however, improved, and it was thought that country life, fresh air and sunlight would be more beneficial than further hospitalization. At the time of discharge, the urine showed a few pus cells.

The patient disappeared from our view, but we have recently learned from her that she completely recovered after a period of six months, during which time the sinus drained off and on. Since this time, she has been perfectly well, has gained in strength and weight, although

during the past twelve months she has been troubled with furunculosis. Within the past few days, an intravenous pyelogram has been secured. The left kidney was normal, but on the right there were no details of the kidney to be seen other than a contracted renal shadow, vaguely made out. We were unable to secure a retrograde pyelogram.

Previous to her operation, the possibility, even in the absence of hematuria, of there being a renal tumor with infection, impressed us strongly, and it must be admitted the thought of carbuncle did not occur to us. The operative findings led us to make a diagnosis of chronic fibro-lipomatous perinephritis with abscess. The pyelographic findings continued to puzzle us, none the less, and the slide has remained, labelled with an interrogation mark. Now, with the benefit of our further experience, the history of a carbuncle and the course of her illness have made us feel that we were dealing with a renal carbuncle. Naturally enough, a positive diagnosis of carbuncle of the kidney cannot be maintained, without actual verification of the lesion.

The definite value of pyelography in this case in arriving at a diagnosis, and in demonstrating the restoration of the kidney to normal, would appear to be clearly demonstrated. Most writers who have made use of the method ascribe to it, at the most, but a negative value. So Lazarus, and Prives, who are of the opinion that the unaltered pelvis in the pyelogram is valuable. Thomas and Exley report in similar fashion. Recently, Ljunggren has reported a case in which the findings elicited by pyelography, both retrograde and intravenous, played the decisive rôle in making the diagnosis. Campbell has recently reported two cases of renal carbuncle, occurring in infants of eight weeks. In one of them a pyelogram was secured, which resembled one of renal tumor, with which diagnosis the operation was performed. By a reasoning which we cannot follow, he has ascribed the pelvic distortion to extra-renal pressure by the perinephritic abscess, rather than to the carbuncle. In support of our argument for the reverse of this supposition, we invite you to view the sectioned kidneys of our two fatal cases, in neither of which a pyelogram was made. We are convinced that pyelography would have revealed typical tumor pyelograms in both cases, had it been carried out. It is to be noted, further, that Braasch suggests that the exaggerated deformities in pyelograms in cases of perinephritic abscess are due to concomitant alteration of the renal parenchyma, and in one of his cases he suggests that deformity is due to a cortical abscess.

As far as therapy of renal carbuncle is concerned, the latest

publications show a tendency to a greater degree of conservatism in its treatment. While in most instances recovery can be secured by nephrectomy, the possibility of involvement of the second kidney must be kept in mind.

Resection, enucleation, incision, curettage and drainage of the abscess alone, have been employed though a subsequent secondary nephrectomy has been occasionally necessary. Neff has analyzed the results of fifty-seven cases operated upon by various methods. He, himself, is an advocate of the conservative method of enucleation.

Conservative therapy in this respect, as in others, will be possible only if early diagnosis of the condition is made.

CONCLUSION

1. Two fatal cases of bilateral renal carbuncle are reported, both proven by autopsy.
2. One of the fatal cases showed a typical carbuncle of the liver.
3. Two cases of presumable renal carbuncle with perinephritic abscess are reported. Both patients recovered following drainage of the abscess.
4. The value of the pyelogram in arriving at a diagnosis has been demonstrated in the two cases of presumed renal carbuncle.
5. The advantages of early diagnosis and conservative therapy are emphasized.
6. In all obscure cases, where even slight signs and symptoms suggest urinary tract involvement, a full urologic study should be made.

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CARBUNCLE OF THE KIDNEY

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Carbuncle of the kidney has been recognized and described more frequently in recent years. Despite the fact that Israel first described this lesion in 1891,[8] I have been able to find only ninety-two instances reported in the available literature. The exact nature of some of the earlier reports suggests the possibility of confusion between carbuncle and cortical abscess or localized perirenal suppuration. As has been recently stated by Brady,[3] a surprisingly large number of surgeons and even urologists are either ignorant of the fact that a carbuncular lesion may occur in the kidney or deny the aptitude of the designation of carbuncle to this type of suppurative condition. Moore[15] clearly defines carbuncle of the kidney as a metastatic, circumscribed, conglomerate suppurative process usually caused by the Staphylococcus aureus, having its origin in some superficial focus, such as a furuncle, paronychia or carbuncle. MacMyn[13] briefly states that the main pathologic features of the condition are a hematogenous infection of the interstitial tissue of the kidney, following an infective condition of the skin such as a boil, whitlow or carbuncle; a localized necrotic zone in the kidney substance with multiple suppurating foci; and later the formation of circumscribed abscesses with enlargement of that part of the kidney which is involved in the suppurative process.

Campbell's[4] recent report of two babies, each eight weeks of age, one male and one female, both of whom died with renal carbuncle, demonstrates that infants may suffer from this lesion as well as adults. Including the two patients I am herewith describing the reported instances of renal carbuncle total ninety-four. Fifty-seven of these were males, twenty-four females and the sex was not recorded in thirteen. The right kidney was involved in forty-one patients, the left in thirty-two, bilateral in three, and not recorded in eighteen. In only three instances were two carbuncles found in the same kidney. In forty-four of the ninety-four cases an associated perinephritic abscess was present. The age of occurrence

varied from eight weeks to fifty-six years. The primary focus has most frequently been a superficial or cutaneous infection. Carbuncles, furuncles, paronychia and cellulitis are the most commonly described. Acute sore throat and upper respiratory infec-

Fig. 1. Carbuncle filling upper pole of left kidney.

tions have occasionally been the only obvious atrium of infection. Neff reported a case of carbuncle of the kidney following a periostitis of the sternum due to the staphylococcus. In comparatively few cases no prior focus was apparent.

While the time elapsing between the onset of the primary focus and the clinical recognition of the kidney carbuncle is variously described as from one to two months, it is obviously quite impossible to generalize as to the usual duration of development. In

Fig. 2. Carbuncle completely filling lower pole of left kidney.

the vast majority of cases the causative organism has been the Staphylococcus aureus.

The gradual onset of symptoms accompanied by fever, headache, malaise, loss of weight, insidiously progressing to the development of pain in the back and loin with lumbar tenderness and pain in the costovertebral angle, are typical of both renal carbuncle and perinephritic abscess. A history of prior cutaneous infection

is common in both conditions. Complete absence of urinary symptoms, as dysuria, frequency of urination and pyuria, is an outstanding feature of both conditions. Unless free communication has been effected between the carbuncle and the calices, and this is rarely described, there is no evidence of urinary infection. Albuminuria, when it occurs, is usually of toxic origin.

Fig. 3. Carbuncle replacing entire lower pole of left kidney. Slight compression of the inferior calices.

A leukocytosis, predominantly polymorphonuclear, is usually present. The differential problem is not usually one of excluding an acute renal infection, as multiple cortical abscesses or acute renal infarction, but rather of distinguishing between massive localized infection (carbuncle) and perinephric suppuration. They may, of course, co-exist. The differential points rest entirely on physical findings, divided renal function tests and X-ray studies.

Pre-operative diagnosis of carbuncle of the kidney has been

rarely made. The differentiation from perinephritic abscess is often impossible and has to be proven by the findings at operation. However, I believe, from the information which can be gained by a thorough study of these patients, that in some at least a fairly positive diagnosis of renal carbuncle uncomplicated by perinephritic

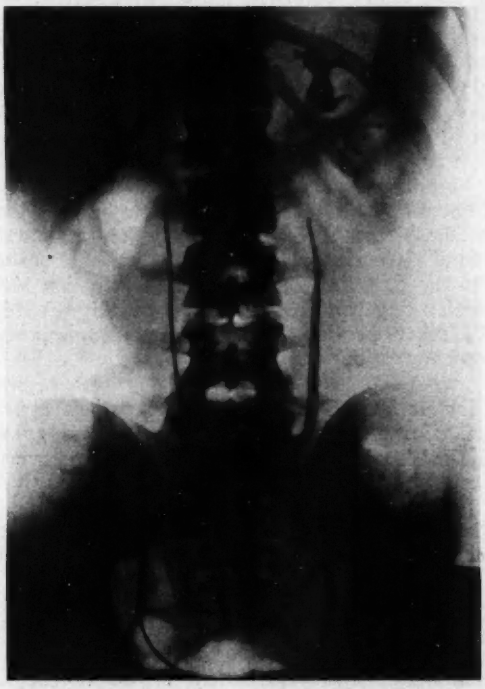

Fig. 4. Left pyelogram showing filling defect of inferior calix and enlargement of lower pole of kidney from carbuncle.

abscess can be made. For this reason I wish to outline in some detail the history of two patients in whom such a diagnosis was correctly made and confirmed by operation. In addition both of these lesions presented such typical findings as to leave no doubt in my mind as to the accuracy of their designation as renal *carbuncles.*

CASE REPORTS

Case 1.—An unmarried Norwegian girl, aged twenty-three years, entered the Washington Boulevard Hospital under the care of Dr. S. R. Slaymaker on June 18, 1930. She stated that five weeks prior to admission she had been taken with a sudden severe pain in the left lumbar region extending anteriorly along the costal margin. She described the pain as a "through and through" pain but experienced no radiation of the discomfort to lower abdomen, groin or scapular regions. Two hours after the onset of the pain she had a severe chill with elevation of temperature to 104 degrees. She was taken to a hospital where she had been in bed constantly since. During this time she lost thirty pounds in weight, had constant pain in the left upper abdomen and back, recurrent chills and daily intermittent fever. Nausea and vomiting occurred daily and there had been frequent severe night sweats. The physicians who saw her previous to transference to this hospital told the relatives she had a "bowel and blood stream infection." On close questioning the patient recalled that two weeks prior to the first chill she had had an infection about the nail of the right index finger which had healed quickly after incision and drainage. All other previous history seemed unimportant. There had never been any urinary symptoms.

Clinical Examination.—On admission the patient appeared weak, thin and pale. Temperature was 103 degrees and pulse rate 120. There was marked localized tenderness in the left costovertebral angle but no mass could be palpated in the left abdomen and the left kidney could not be felt on deep inspiration. Rectal examination under gas-oxygen anesthesia showed normal uterus and adnexa and no evidence of pelvic inflammation. Blood pressure was 120 systolic and 80 diastolic. Voided specimen of urine was clear, alkaline, showed no albumin, sugar, casts, pus or red blood cells. Blood count: 4,040,000 red blood cells, 16,800 white cells and 70 per cent hemoglobin. X-rays and fluoroscopy of the chest gave normal findings, as did complete gastro-intestinal study. I saw the patient on June 26 (eight days after admission and six weeks from the onset of symptoms). At this time the leukocyte count was 23,500; daily urinalysis had been normal and the temperature variation had been from 98 to 103 degrees daily. There was localized tenderness in the costovertebral region, especially on deep percussion from behind. The left kidney was not palpable and there was no bulging in the flank. X-ray study at this time showed normal psoas muscle outline and a high slightly enlarged left kidney shadow. On fluoroscopy there was no fluid wave suggestive of perinephritic abscess. Cystoscopic examination showed a normal bladder and both ureters were readily catheterized 30 cm. The urine from either kidney was normal in every respect. Cultures of bladder

and divided kidney specimens were negative. After intravenous injection of phenolsulphonephthalein, the dye appeared in three minutes from the right and in eight minutes from the left. Excretion from right was 15 per cent; from the left 10 per cent in fifteen minutes. A left pyeloureterogram showed normal outline of left ureter and pelvis and normal middle and inferior calices. The superior calix branches were flattened and more widely separated than normal, giving the appearance of pressure being exerted from above, although the minor calix outlines were normal.

The history, clinical examination and urologic findings suggested a massive infection at the upper pole of the kidney. A diagnosis of carbuncle of the upper pole of the kidney was made, although it was impossible to rule out the possibility of a localized perinephric abscess in this region.

Operation.—On June 28, 1930, the left kidney was exposed through a lumbar incision. There was no perirenal suppuration. The kidney was densely adherent to the diaphragm and the upper pole was surrounded by thickened adherent fat. After delivery of the kidney the upper pole comprised a hard, nodular mass covered with sclerotic fat. On removal of the fatty tissue a typical carbuncular mass was exposed and attempts were made to cut about the carbuncle and enucleate the major portion. This procedure being unsatisfactory it was deemed advisable to remove the kidney. Nephrectomy was easily accomplished and the wound adequately drained.

Pathologist's Report.—(Dr. W. G. Hibbs) "The entire upper pole of this left kidney is occupied by a carbuncular mass (multiple deep abscesses) which on microscopic section contains dense clumps of partially disintegrated polymorphonuclear leukocytes, serum and debris. Here kidney substance is absent. Diffused throughout the kidney, between tubules and in glomeruli, is widespread infiltration of leukocytes which are about equally polymorphonuclears and lymphocytes. Portions of the kidney elsewhere are without change except that some of the tubules contain coagulated serum. Pus from the abscesses on culture yields a pure growth of Staphylococcus aureus."

Convalescence.—The patient recovered nicely from the operation, the temperature being normal on the third day. She began to gain in strength and her appetite improved, but on the fifth postoperative day her temperature rose to 104 degrees and from then on until August 13 the daily variations continued from 98 to 103 degrees. The leukocyte count varied from 12,000 to 15,000 during this time. Blood cultures were negative on four occasions. An endocarditis was feared but the cardiac condition remained normal. Despite this febrile course the patient gained in weight and strength; she had no pain and the incision healed cleanly by first intention. Three weeks after opera-

tion she had a small furuncle on the right upper arm. This was incised and drained and healed readily. Staphylococcus antivirus was injected into the drainage site of the wound, intravenous arsenicals were given but with no apparent effect on the temperature. Finally four daily intravenous injections of 10 c.c. of 10 per cent metaphen were given without reaction and two days later the temperature remained normal until the patient's discharge from the hospital on September 2 (eleven days afebrile). Whether the metaphen had any specific effect is open to question, as the patient was improving steadily despite her persistent fever.

I last examined this patient in March, 1931. She had gained fifty pounds, felt perfectly well and had had no further sign of infections.

Case 2.—C. D., a school boy aged seventeen years, entered the Garfield Park Hospital under the care of Dr. William A. Plice on December 10, 1931. He complained of weakness, anorexia, loss of weight and pain in the left lumbar region. In the latter part of October he had a large, painful furuncle on the left chest which was ruptured by trauma during a game of football. This area healed quickly but during the following month he felt tired and lazy but continued to attend school and had no pain or other unusual symptoms. On November 25 he developed a backache, mostly on the left, which could not be relieved by massage, hot applications or salicylates. For the next two weeks he was confined to bed with the pain gradually localizing in the left lumbar region and becoming more constant and severe. There was intermittent nausea and vomiting on five occasions. The attending physician found at this time that the boy was running an intermittent temperature varying from 100 to 103 degrees but all physical signs, except tenderness in the left lumbar region, were negative. All other previous history seemed unimportant.

Clinical Examination.—On admission he appeared ill, thin and pale. Temperature was 102 degrees and the pulse rate 90. There was slight tenderness on pressure in the left lumbar region. There were no other physical signs. The blood pressure was 130 systolic and 90 diastolic. Voided specimen of urine was clear, amber, alkaline, specific gravity 1012, with slight trace of albumin, no sugar, occasional hyalin cast, one to two pus cells per high power field, occasional red blood cell, many triple phosphates, no bacteria. Blood count was 16,000 leukocytes, 5,400,000 red cells, 80 per cent hemoglobin; coagulation time four minutes; differential count, neutrophils 88 per cent, lymphocytes 10 per cent, large mononuclears 2 per cent. Widal test negative. Wassermann and Kahn tests negative. The urine sediment showed no tubercle bacilli, many Gram-negative bacilli, a few Gram-positive diplococci and a few pus cells. During the succeeding two weeks the patient continued to show a temperature variation from

99.6 to 103.4 degrees, leukocytosis varying from 18,000 to 24,000 and a gradually developing secondary anemia. On December 24, I first saw the patient in consultation and found a marked tenderness in the left kidney region but no other physical signs of note. An X-ray study at this time showed an enlarged left kidney shadow but no obliteration of the left psoas muscle outline. Cystoscopic examination showed a normal bladder and the ureters were easily catheterized 30 cm. The urine from both kidneys was macroscopically clear. On analysis the specimen from the right kidney was normal in every respect. From the left eight to ten pus cells and two to three red blood cells were found after centrifugalizing. Culture from the left showed Gram-positive cocci (staphylococci). After intravenous injection of phenol-sulphonephthalein the dye appeared from the right kidney in three minutes but did not appear from the left for twenty-one minutes. Excretion from the right was 4 plus, from the left 2 plus. A left pyeloureterogram made by injecting 8 c.c. of 12 per cent sodium iodide showed a marked displacement of the renal pelvis and upper few centimeters of the ureter toward the midline. The outline of the pelvis, superior and middle calices was normal but the inferior calix was elongated, retracted and distorted in the region of what appeared to be an enlargement of the lower pole of the kidney.

A review of the history, clinical course and urologic findings seemed to indicate quite definitely the presence of a massive localized infection in the lower pole of the left kidney. A diagnosis of carbuncle of the kidney was, therefore, made and operation advised. While it is either difficult or impossible in most instances to rule out perinephritic abscess in a situation of this kind, the X-ray findings showed no obliteration of the psoas outline, no elevation of the diaphragm and on fluoroscopy no fluid wave could be noted. The enlarged lower pole outline, the median displacement of the pelvis and upper ureter and the irregularity, retraction and distortion of the inferior calix when considered with the history and clinical findings prompted the diagnosis of renal carbuncle uncomplicated by perinephritic abscess.

Operation.—On December 29, 1931, the left kidney was exposed through a lumbar incision. There was no perirenal suppuration. The perinephric tissues were densely matted together and the lower pole region was slightly edematous. The tissues about the pedicle were densely matted together but the upper pole was easily isolated. A nodular, dense mass covered with adherent and indurated fat comprised the lower pole. On removal of the adherent fatty tissue there was exposed an area identical in appearance with a subcutaneous carbuncle which extended to the center of the kidney substance. Because of this extensive involvement resection of the involved portion of the kidney or of the carbuncle itself seemed impractical and nephrectomy was done, removing as much perinephritic fat as possible.

Pathologist's Report.—(Dr. Paul Schmitt and Dr. R. H. Jaffé) "The lower pole of this kidney is enlarged to one-half larger size than the upper pole by a tumor mass measuring 4 inches in diameter. This mass is sharply circumscribed. The surface has a mottled appearance and multiple drops of yellowish-white material exude from the surface when deep pressure is applied. Smears of this substance show pus, detritus and Gram-positive cocci (staphylococci). On cutting, the surfaces present radiating strands of a pale gelatinous-appearing, fibrous tissue between which are numerous islands of a bright yellow, somewhat crystalline appearing substance having a radiating formation. Over the entire surface are numerous small cavities containing a thick, tenacious, green material. The renal pelvis and attached portion of the ureter are normal. The capsule over the mass is greatly thickened. Microscopic examination of the above mass reveals a marked inflammatory reaction with almost complete destruction of the kidney parenchyma. There is a dense infiltration of all types of inflammatory cells. The outstanding feature is the presence of large islands of densely packed microphages having a glassy appearance somewhat like adrenal cells. Smears from these cavities also show Gram-positive cocci.

"Diagnosis: Carbuncle occupying entire lower pole of left kidney."

After operation the temperature ranged from 98 to 100.8 degrees for ten days but then became normal. Convalescence was rapid and uneventful except for a slight separation at the anterior margin of the wound which rapidly healed. The patient was up and about January 12 and was discharged in good condition on January 21.

COMMENT

In both of these patients, as can be seen from the illustrations, the carbuncle was so extensive that nephrectomy seemed the safest treatment. A gentle attempt was made in each instance to enucleate the mass but when this seemed impracticable the procedure was not forced. Neff's[17] report before this Society two years ago and his suggestion as to successful enucleation were borne in mind. Brady's recent report of a single success following freeing of the renal capsule and simple drainage without incision of the carbuncle deserves attention.

The possibility of a carbuncle developing in the opposite kidney after removal of an affected kidney seems uncommon. Kretschmer[11] reported such a case in 1922. Stuckey,[27] a Russian, reports a patient in whom he successfully drained a carbuncle of one kidney and five years later a carbuncle in the other kidney was diagnosed and drained. Complete recovery ensued.

Mathé[14] has called attention to the abnormally high fixation of the kidney when the carbuncle involves the upper pole. This observation plus the flattening of the superior calix, as shown by the pyelogram, helped us to a correct diagnosis in the first patient. The pyelographic outline in the second patient could only be confused with renal neoplasm and the clinical diagnosis of carbuncle seemed quite definite. In neither of these patients was there any evidence of ureteral or calix obstruction as a primary factor. The febrile postoperative course, in the first patient described, occurred in the absence of any apparent infection of the renal fossa or wound. Blood cultures were repeatedly negative during this period but the patient probably had a persistent staphylococcic focus elsewhere in the body which healed spontaneously.

SUMMARY

1. Two instances of renal carbuncle, both in the left kidney, were correctly diagnosed before operation. Diagnosis was made possible by X-ray studies coupled with the history and clinical examination.

2. Complete recovery followed nephrectomy.

3. As near as I can ascertain, this report brings the total to ninety-four reported cases.

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KIDNEY LESIONS AS A CAUSE OF GASTRO-INTESTINAL SYMPTOMS

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Symptoms due to disorders of the urinary tract may be so suggestive of lesions of the gastro-intestinal tract that the correct diagnosis is obscured. This fact has been well recognized for many years and numerous writings refer to the frequency with which such patients have been operated upon before the true condition has been recognized. Cecil,[2] in 1920, commented on this, and remarked that abdominal exploration had been performed in 30 per cent of a group of individuals with hydronephrosis. Little has been said in the past, however, to account for this close association between the kidneys and the gastro-intestinal tract.

Gastro-intestinal symptoms are frequently encountered in diseases of the urinary organs, particularly the kidneys. In many instances they are manifestations of uremia and an evidence of failing renal function. At other times such symptoms are obstructive in character and result from the pressure of large renal tumors on adjacent structures. The marked gastro-intestinal disturbances which sometimes arise from catheterization of the ureters, pyelography, calculus disease, or hydronephrosis, however, have a possible explanation in reflex impulses along sympathetic nerves.

The kidney is innervated by sympathetic fibers. Since one of the chief functions of the sympathetic nervous system is to put the various organs of the body in relationship to one another and assure their proper coördination,[8] it is not unreasonable to suppose that dysfunction in one organ should give rise to symptoms in other organs through the relationship provided by the sympathetic nerves. Such phenomena have been recognized for a long time and have been called "viscero-visceral reflexes."[8] Familiar examples are the spasms of the gastric or intestinal musculature from an inflamed appendix, and reflected pain in the testicle due to a stone in the ureter or renal pelvis.[10]

The renal plexus of nerves arises by fibers from the solar plexus, the splanchnic nerves, the inferior mesenteric ganglion, a

branch from the first lumbar sympathetic ganglion, and probably fibers from the vagus. These nerve fibers run along the renal arteries, anastomose freely, and in their course form several small ganglionic masses. The nerves enter the hilum of the kidney, branch with the blood vessels, and end in the glomerular capsules, tubules, and between the epithelial cells. Through the superior and inferior mesenteric ganglia the renal plexus is connected with the sym-

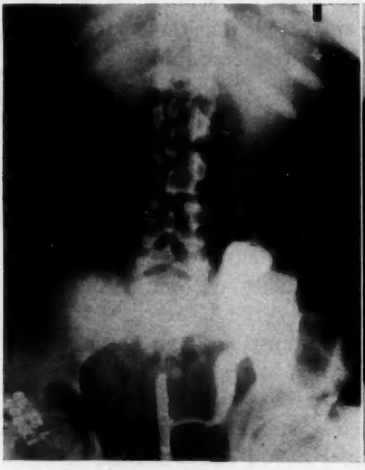

Fig. 1. Case 1. Right ureterogram. Dilatation of the ureter was so marked that the renal pelvis did not fill with the sodium iodide solution.

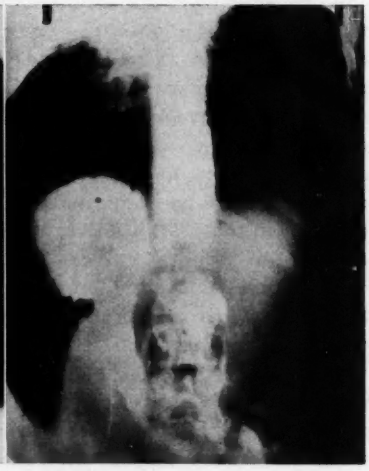

Fig. 2. Case 1. Showing the stomach filled with barium and displaced to the left.

pathetic nerve supply of the stomach and intestines.[1,4,6,7,9] Anastomoses between the renal plexus and the aortico-mesenteric ganglia, which supply the stomach, have been shown to exist, and appear to be present most frequently on the right side.[1,9] Direct nerve fibers connecting the renal plexus with other plexuses have been demonstrated by anatomical dissections, though the actual arrangement of the fibers varies in different individuals.[6,9] In this association the right kidney appears to be most closely connected with the stomach, small intestine, and colon; the left kidney with the descending colon and rectum.[3] These facts possibly ac-

count for the greater frequency of dyspeptic symptoms from right sided than left sided kidney lesions. Stimulation of the nerve supply of the kidney and upper ureter in animals has been shown to cause disturbances in the intestinal musculature.[3,5] Although little work has been done along these lines, definite communications have been demonstrated between the sympathetic nerves supplying the kidney and various of the gastro-intestinal organs. More work is necessary to demonstrate the physiologic effects on other organs by stimulation of the renal nerves.

That the outstanding symptoms in certain instances of renal disease may be those of disorders of the gastro-intestinal tract, without there being present any of the usual signs of urinary tract lesions, is well illustrated by the following cases.

Case 1.—The first case is that of a truck driver, thirty-four years old, referred to the medical wards of the Massachusetts General Hospital July 10, 1929, from the Consultation Clinic of the hospital, with the diagnosis of complete duodenal obstruction. The chief complaint was attacks of vomiting. For the past ten years such attacks had occurred about every two months. Recently, however, they had become more frequent and were now of nearly daily occurrence. The vomiting was projectile in character and at times was preceded by an aching pain across the lower back. They were always accompanied by abdominal distress and nausea, sometimes by the eructation of foul gas. Vomiting invariably gave immediate relief of all distress. Attacks of abdominal pain frequently took place at night, awakening the patient from a sound sleep and causing him to vomit. A milk diet had relieved the vomiting, but the resumption of a more liberal diet had caused the symptoms to return at once. Sodium bicarbonate had afforded some relief. When hungry, a gnawing epigastric pain had been present. For the past eight months work had been impossible. Appendectomy nine years ago had failed to stop the vomiting.

Physical examination showed a healthy appearing individual with no abnormalities except the presence of a firm, smooth mass in the right upper quadrant of the abdomen. The urinary sediment contained a few leukocytes; other laboratory tests were normal. A diseased gall bladder was considered the most likely diagnosis.

X-ray examination was unusually interesting. A barium meal demonstrated a large twenty-four hour residue in the stomach, the stomach and first portion of the duodenum were displaced to the left, and the duodenum was considerably dilated. No barium could be forced through the second and third portions of the duodenum. The hepatic flexure of the colon showed a slight concavity in the region of the palpable mass. A Graham test failed to show any filling of the gall bladder. These findings were interpreted as probably being due to a mass

in the right kidney region. A small outpocketing in the middle third of the stomach was suggestive of a gastric ulcer.

Study of the urinary tract revealed the presence of marked dilatation of the right kidney pelvis and ureter. Although there was no renal infection, the function of the right kidney was seriously impaired.

At operation a right hydronephrosis about the size of a grapefruit was found. The renal pelvis was tremendously enlarged and the renal

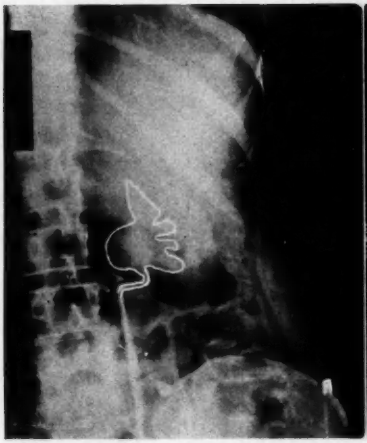

Fig. 3. Case 2. Right pyelogram. Showing moderate dilatation of the kidney pelvis and angulation of the ureter.

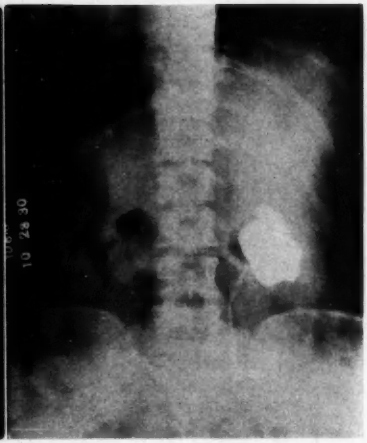

Fig. 4. Case 3. Right pyelogram. Showing marked deformity of the kidney pelvis and narrowed ureter.

cortex very much thinned out. A small blood vessel crossed the uretero-pelvic junction and may have been a factor in the production of the hydronephrosis. Kidney damage was obviously beyond repair and the organ was removed.

X-ray examination at the time of the patient's discharge from the hospital showed the stomach and duodenum in approximately normal position with no obstruction present. Relief from symptoms was immediate and when seen a year after operation he reported that he had had no further vomiting or pain, felt well, and was able to eat anything he wished.

Case 2.—The second case is that of a nurse, forty years old, who complained of intermittent attacks of nausea and vomiting. Although previously in good health, for the past two years she had noticed a great deal of gas, frequent belching, and on many occasions while on

duty she had found it necessary to leave the room suddenly and vomit. The vomiting had no relationship to meals. Chronic constipation had necessitated the use of many cathartics. There had been no abdominal pain or urinary symptoms. About two years ago radium had been employed to check excessive bleeding due to fibroids.

Physical examination showed nothing abnormal. Under the impression that the symptoms were due to a lesion of the gastro-intestinal tract, a barium meal was given. X-rays showed on several occasions a normal stomach and bowel and a normal gall bladder. The urine was normal save for an occasional leukocyte in the sediment. The urinary tract was examined for the sake of thoroughness, and because of the other negative findings, although none of the symptoms suggested any renal lesion. The left kidney was normal, the right kidney pelvis was moderately dilated, and the upper portion of the ureter was sharply angulated. Both kidneys functioned well and the urine was sterile.

Operation on July 2, 1926, showed a moderate degree of dilatation of the right renal pelvis and a low movable kidney. A small vessel, probably a vein, crossed the uretero-pelvic junction. This anomalous vessel was divided, and the kidney suspended.

This patient was recently seen, nearly six years after operation. There have been no further attacks of nausea and vomiting, and the constipation has disappeared.

Case 3.—A third case is that of a housewife, forty-six years old, who had had stomach trouble and abdominal discomfort for many years. Three years ago the removal of a stone from the right kidney had relieved the symptoms for six months. Since then, however, she had had upper abdominal discomfort, frequent belching of gas, and a poor appetite. Abdominal discomfort was aggravated by eating. No urinary symptoms had been present.

Physical examination showed nothing of consequence except epigastric tenderness. Gastro-intestinal X-rays demonstrated a normal stomach and bowel, except that the stomach appeared displaced somewhat to the right. The urine contained only an occasional leukocyte. A right pyelogram showed a much dilated and deformed renal pelvis with a narrow and tortuous ureter in its upper portion. Cultures of the kidney urines were sterile.

Operation was performed on October 24, 1930. A low kidney was exposed whose ureter was extremely narrow in the upper third. The kidney cortex was thinned out to a considerable degree and the pelvis dilated. The kidney was removed. Since operation the patient has been entirely relieved of the gastro-intestinal symptoms and abdominal discomfort, and has gained in weight.

These three cases are striking examples of renal lesions with outstanding gastro-intestinal symptoms. In the first case these

symptoms could easily have been due to the pressure of a large hydronephrotic mass on the second portion of the duodenum, in other words, mechanical in nature. In the other two cases, however, the mass was not sufficiently large to cause any pressure on the bowel, and gastro-intestinal X-ray studies had shown no obstruction. There were no changes in the gastro-intestinal tract to account for the digestive disturbances, the only demonstrable lesions being those of the right kidney. Removal of the renal pathology resulted in the complete disappearance of the gastro-intestinal symptoms.

The sympathetic nervous system is being taken into account more generally as an explanation of pathologic visceral phenomena and it seems reasonable to suppose that in the instances here given reflex impulses between the diseased kidney and the stomach or bowel provide an explanation of the symptoms.

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PIGMENT IN THE GLOMERULI AND URINIFEROUS TUBULES

CASE REPORT

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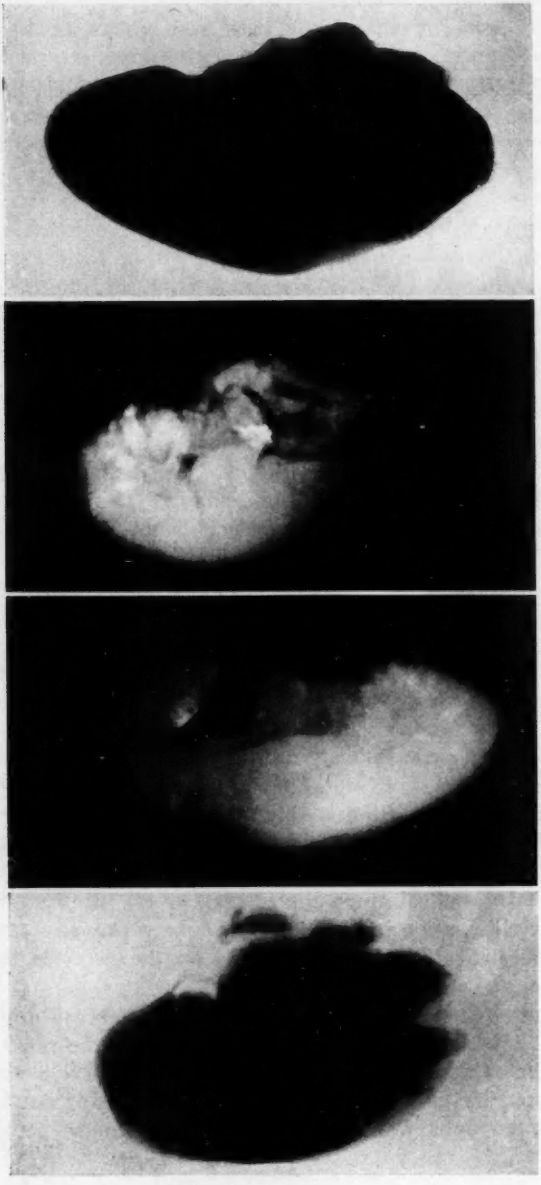
Hemoglobin and other pigments have been repeatedly demonstrated in the glomeruli and uriniferous tubules. Many investigators have been able to show these deposits after injecting blood, Ringer's solution, or a watery solution of hemoglobin intravenously. Experiments conducted in the Laboratory of the University of Tennessee, under Dr. W. R. Amberson, where hemolyzed blood was injected intravenously in dogs and cats, have confirmed the finding of hemoglobin in the glomeruli and uriniferous tubules. The method employed in these experiments consisted in separating the blood cells from the serum by centrifuging. The blood cells were then washed several times in Ringer's solution, hemolyzed by the addition of distilled water and made isotonic with blood by adding 1 per cent glucose and injected intravenously; 20 to 30 c.c. being given to an average size cat. Sections of the kidneys of the injected animals showed deposits of pigment (hemoglobin) in the glomeruli and uriniferous tubules.

Miller[5] (1912) states that "hemoglobin may be detected in the epithelial cells of the convoluted tubules and the loop of Henle, but Baehr (1912) points out that this may be of the same nature as the granular staining with special stains and thus accepts Ribbert's view that the hemoglobin issues from the capsule and is concentrated in its passage through the tubules by the absorption of the fluid. The elimination by the capsule has been proved, that by the convoluted tubules is merely suggested on the grounds as determined by experience with carmine."

"Frequent injections of superthreshold amounts of dog hemoglobin will cause deposits of pigment material in the renal epithelium. When this has happened the dog will survive minimum lethal doses of mercuric chloride with little evidence of renal injury. In fact, some dogs will tolerate twice the minimal lethal dose



Figs. 1-4. Photographs of right kidney showing infarct-like areas in the cortex.

without severe reaction. There is no evidence that continued injections of dog hemoglobin in these amounts will cause any injury or functional disability of the kidney."[2]

"It is our belief that in these experiments the hemoglobin escapes through the glomerular tuft. If the convoluted tubules are normal, we note that hemoglobin is taken into the epithelium. With repeated hemoglobin injections this tubular epithelium becomes stuffed with hemoglobin pigment and can absorb no more."[3]

"Doses of hemoglobin definitely below the glomerular threshold, although given over long periods of time, never cause any deposits of iron containing pigment within the tubular epithelium of the kidney, although all the other organs are pigmented exactly as though a superthreshold series of hemoglobin injections had been given."[4]

In 1930 G. Halter[1] reports a case of hemoglobin in the convoluted and straight tubules following transfusion due to hemolysis. Death resulted from uremia due to occlusion of the uriniferous tubules.

CASE REPORT

S. L., white, Hebrew, aged forty-seven, was admitted to the Baptist Hospital January 17, 1932.

The chief complaint was pain—a dull heavy ache with intermittent colic in left loin and back.

Family history was negative.

Past history was negative except on July 12, 1926, the patient took a tablespoonful of Agarol to which someone had added bichloride of mercury (reported by a chemist as a large quantity). He swallowed only a small amount, as it burned his mouth, tongue and throat so severely he spit out most of it. He suffered nausea and vomiting and was immediately given warm salt water, which caused more vomiting, and later he was given raw eggs and milk. No diarrhea, cramping, salivation or other symptoms of mercurial poisoning ensued. About one week later he had an attack of acute, severe colicky pain in the left loin and back, which radiated to the left groin and testicle. He has had one or two similar attacks every year since. In the past year they have become more frequent, two attacks having occurred in the past three weeks. He has had some frequency of micturition following these attacks but no hematuria and has never passed any calculi or sand.

The patient had an attack of severe colic in the left loin and back, radiating to the left groin and testicle, three weeks ago, which neces-

sitated a hypodermic of morphine for relief. Since that time he has had a more or less dull heavy ache in the upper left quadrant and three days ago he had another severe attack of colic. He has passed no macroscopic blood but his local physician found red blood cells in his urine.

Examination revealed a well nourished, well developed Jew, age

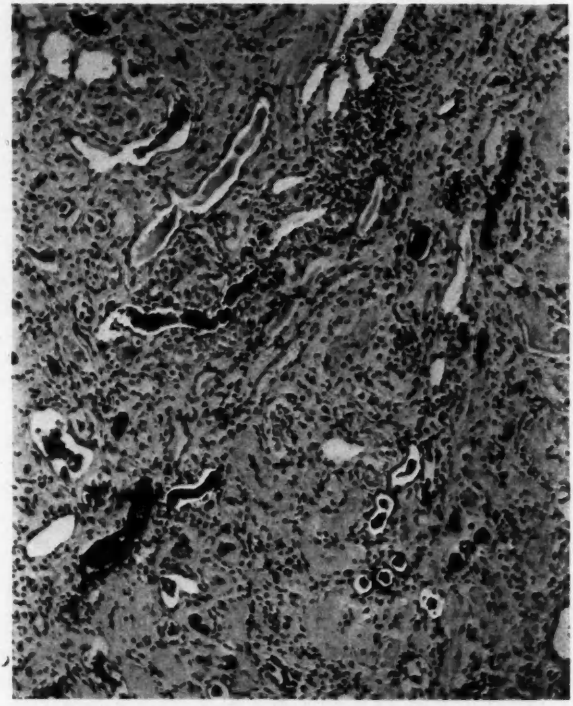


Fig. 5. Pigment (hemosiderin) in the uriniferous tubules.

forty-seven, complaining of dull aching pain in the upper left quadrant. Neither kidney was palpable, but there was pain on first percussion over the left kidney region. Heart and lungs were negative. Urinalysis showed amber, acid 1.010, no albumin, no sugar, no casts. There were two to three pus cells, five to ten red blood cells and an occasional epithelial cell to the high power field. The blood count showed 4,800,000 red blood cells, 12,550 leukocytes, 77 per cent polymorphonuclears and hemoglobin 85 per cent. Blood chemistry was

N. P. N. 18.9 mg. per 100 c.c. of blood. Creatinin 1.2 mg. per 100 c.c. of blood.

Cystoscopy showed a mild chronic cystitis. The right ureteral orifice was normal; the left was reddened. A No. 6 X-ray catheter passed easily to each pelvis and there was a free flow of clear urine from each. P. S. P. appeared in three minutes from the left kidney

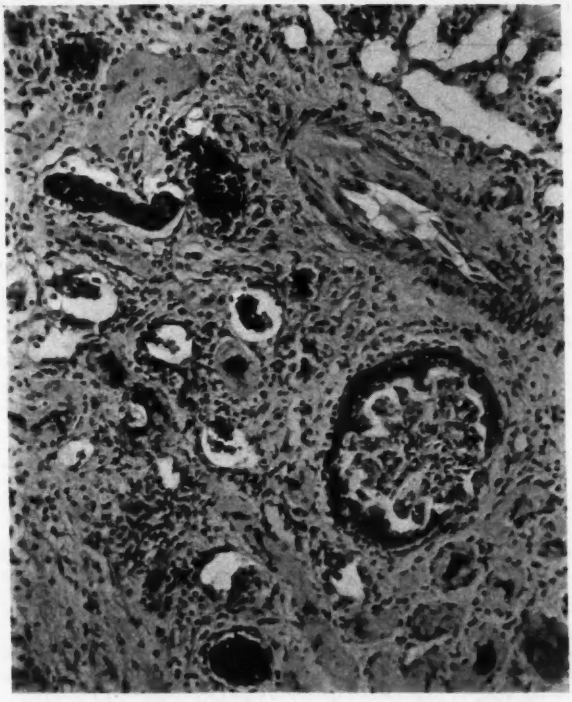


Fig. 6. Pigment (hemosiderin) in a glomerulus and uriniferous tubules.

—two minutes from the right; 10 per cent in fifteen minutes from the left kidney—18 per cent from the right.

X-ray report showed that catheters were well up in both ureters. There was a stone shadow about 3.5 cm., and 2 cm., showing in left kidney pelvis in the middle calix. Left pyelogram showed the stone shadow covered by the opaque media. There was marked dilatation of the lower calix and some blunting of the other calices. The entire

left ureter was dilated. In the right pyelogram the pelvis was only partly filled, but showed fair cupping of the upper calix.

Kidney specimens revealed: left, 20-25 red blood cells, two or three pus cells and many epithelial cells to the high power field; right, a rare pus and epithelial cell in the entire field. Cultures of the right were negative; left, Staphylococcus aureus.

Operation, January 22, 1932, consisted of a left nephrectomy. The usual oblique kidney incision was made. The kidney was of normal size and easily freed, but the ureter was found to be enlarged to the size of the little finger. The pedicle was transfixed and ligated with chromic catgut No. 2, two ligatures, and the kidney removed. The wound was closed (with a cigarette drain to the pedicle stump) with No. 2 chromic catgut for muscles and fascia, silkworm gut and plain No. 1 catgut for the skin. One silkworm gut through drain. He made an uneventful recovery, leaving the hospital on the fifteenth day. His wound was completely healed on the twenty-second day.

Pathologic Report (Dr. N. E. Leake).—The kidney measured 12.5x 5.5x3.5 cm.; weight, 165 grams. The capsule was dark red and showed a number of vascular adhesions. Irregular, pale, yellow areas which had the appearance of abscesses could be seen through the capsule. There was a large amount of fat about the dilated pelvis. On cut section the pale yellow areas were found to be slightly elevated and somewhat harder than the surrounding tissue. They were triangular or dagger-pointed with bases at cortical border and looked like infarcts. The pelvis and calices are dilated and lined by a thickened hemorrhagic membrane. The parenchyma was normal in appearance except for the pale yellow areas described above.

Microscopic sections of the kidney were characterized by irregular areas of degeneration in the cortex which were surrounded by rather definite zones of leukocytic infiltration. Many of the glomeruli were obliterated and contained a deposit of granular dark brown material situated chiefly in the malpighian capsules. The convoluted tubules were filled with formless eosin staining material and the same brown deposit was noted in the glomeruli. Much of the lining epithelium had disappeared. Diagnosis: Cause of necrosis and deposit of pigment was undetermined. The pigment was thought to be hemosiderin.

Pathologic Report (Dr. Apfelback, Pathologist, Presbyterian Hospital, Chicago, Ill.).—"The sections of the kidney are characterized by disseminated regions, some several mm. in diameter, where there is acute coagulation necrosis of the cells of the convoluted tubules, brown pigmentation of the center of the tubules and of the glomeruli in the same region, the brown pigment of the latter being chiefly at the periphery of the glomeruli near the capsule. There was marked distortion of the tufts due chiefly to shinkage. Elsewhere in the kidney there are minute regions of round cell and fibroblast prolifera-

tion, both in the cortex and in the medulla, chiefly around the blood vessels and probably in the lymphatics. I believe the changes in the kidney are related to the hydronephrosis and ascending infection. The blood supply has been shut off to the tubules and due either to embolism of the glomeruli or changes in an interlobular artery.

"A personal communication from Dr. H. L. Kretschmer confirms

Fig. 7. Photograph of pyelogram of right kidney, showing blunting and dilation of calices, and obliteration of lower minor calices. There is no evidence of extravasation of pyelographic media, also right ureter dilated throughout.

the finding of pigment (hemosiderin in the glomeruli and uriniferous tubules) both by himself and by Dr. Nicoll, another pathologist in Chicago."

As the kidney was injected with equal parts of neosilvol 35 per cent and sodium iodide 15 per cent for the pyelogram and the patient had once taken bichloride of mercury by mouth, Dr. M. F. Brown of the Department of Chemistry of the University of Tennessee subjected the pigmented areas to repeated tests for silver, mercury and iodine with negative results.

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DISCUSSION

DR. CLYDE L. DEMING (New Haven, Conn.): I have been very much interested in the carbuncle of the kidney. I would like to show a slide representing a case which is, I believe, compatible with the diagnosis of carbuncle of the kidney.

(Slide) A young Polish boy of eighteen was admitted to the hospital in November, was very ill with a temperature of 103, and had a history of an ulcerated tooth one year before, followed in ten days with pain in the right side, which persisted for a year.

Two weeks prior to admission, he had severe pain in his left side. On admission, he was found, by palpation and also by X-ray, to have both kidneys much enlarged. He was treated conservatively for the first two weeks with large intake of fluids and rest in bed.

The X-ray pyelograph showed marked dilatation of the left pelvis, with marked constriction of the upper ureter. The urine was infected with staphylococci.

At the end of four weeks, the kidneys seemed to subside and there developed a mass in the left loin. After another week, we opened what was thought to be an abscess and evacuated 200 c.c. of thick yellow pus. The stain was negative and the culture negative. It required about eight weeks for this wound to heal.

The kidney function test later showed 5 per cent from the left kidney and 40 per cent from the right. After several dilatations of the left ureter, the pyelogram persisted just the same. The emptying time for this pelvis was somewhat over an hour.

At the end of about eight weeks after the drainage of the abscess, we decided to do a nephrectomy. (Slide) This is what we found. The kidney was very much fibrosed around the lower pole with small sinuses leading down to the pelvis.

These did not connect with the pelvis as far as we could make out. There was an acute process going on as seen in the section. (Slide) There were large leukocytes containing fatty lobules. It is the impression of the Pathological Department at Yale School of Medicine that this kidney represents a healing carbuncle of the kidney.

This man is fully recovered and is free from infection.

DR. ROGER C. GRAVES (Boston): The carbuncle of the kidney is exceedingly interesting to all of us, because it is of such infrequent occurrence. We know so little about it that in most instances we miss the diagnosis. I think Dr. O'Conor is to be congratulated on his two cases, in which a correct decision was made before operation. I have been interested in the subject during the past winter because of a patient that I have had recently with bilateral involvement. This young man, twenty-one years old, had a typical and very large carbuncle of the right kidney, which I finally treated by nephrectomy. Then, a number of months later, after going home, he became very ill again and developed the same type of lesion on the left side with a very extensive perirenal suppuration, from which he finally died.

The story of most of these cases appears to be that a surprising length of time passes between the beginning of the symptoms and any sort of correct clinical conclusion as to what is the matter with the patient. The average delay is anywhere from a few weeks to several months, extending in most instances from the time of the onset of illness to the time of operation or autopsy, before a proper diagnosis is made. In my case, six weeks elapsed between the beginning of the fever and the arrival at the hospital for surgical treatment, and during that time the patient had been thought at first to have grippe.

I want also to congratulate Dr. Colby on his paper, because it seems to me that he has presented very well an important subject about which we ought to know more. We are all familiar, of course, with the fact that many of our patients have gastro-intestinal disturbances, but we have been inclined to ascribe them in most cases to the results of varying degrees of uremia. Of course, uremia is a toxemia, and it can vary in its manifestations just as may any toxemia, and sometimes these manifestations may be predominantly gastro-intestinal. We have thought too little and learned too little of the possibility of a "viscero-visceral reflex" serving as the explanation of some of these disturbances in our cases. The sympathetic system is a fearful and wonderful thing, and we know far too little about it, particularly as it applies to the

urinary organs. I hope that Dr. Colby will go on with the research he proposes.

I remember a patient whose experience may bear upon this subject. He was a man of about forty years of age, who for a long time had had an intractable diarrhea. There had been any number of clinical investigations and gastro-intestinal X-ray studies with negative results, until he consulted, just before I saw him, a roentgenologist, who detected in one of his plates a shadow in the region of the right ureter which he thought might be a stone. That led the man, for the first time, to undergo urologic investigation. I found a small calculus impacted in the upper portion of the right ureter, just a little below the renal pelvis. There was a small hydronephrosis of a degree which one might expect to recover with the removal of the obstruction. I took out the stone, divided an aberrant vessel to spare the kidney from further damage, and did not suppose for a moment that I was going to relieve the trouble that the patient chiefly complained of, the diarrhea. Much to my surprise, however, it promptly subsided, and he seemed to be definitely improved in this regard.

The value of that experience is blurred a good deal by the fact that some time later the patient began to have a tendency to a return of his intestinal symptoms. Then his internist discovered some sort of sugar intolerance, the regulation of which by diet kept the diarrhea under control. So I am not certain that this is a case in point, but I thought that it might bear, in some measure at least, upon Dr. Colby's very attractive subject.

DR. H. A. FOWLER (Washington, D. C.): It appears to me this is a very happy presentation of the subject of carbuncle of the kidney in that these two papers presented are mutually complementary, and present two rather distinct clinical varieties of carbuncle of the kidney.

In the first paper, Dr. Patch clearly brought out a relation of carbuncle of the kidney with perinephritic abscess. These two conditions so often obtain as one observes these cases clinically.

In Dr. O'Conor's case, the lesion was clear and clean-cut, in that the lesion was confined to the kidney itself and that perinephritic tissue was not involved in abscess formation.

I think it is difficult in many cases to differentiate between the

carbuncle of the kidney as a distinct lesion and perinephritic abscess. In many cases of perinephritic abscess—in my experience at least—one is satisfied with the opening and free drainage of the abscess without subjecting the patient to further traumatism by an attempt to determine the exact etiology of that perinephritic suppuration.

I think in the majority of the cases—at least that has been my experience—with free drainage in these cases the patient goes on to a very happy recovery, and I think that an attempt in many cases, particularly of large perinephritic abscess, to determine the exact etiology is perhaps rather dangerous, and one should limit one's efforts to securing free drainage.

One point that was brought out by Dr. Patch and referred to by Dr. O'Conor is that in many of these cases where one thinks he has obtained free drainage, the symptoms of fever persist. This has been ascribed to the presence of a carbuncle or a cortical condition of the kidney or what not, persisting after free drainage has been secured.

I recall two cases seen in consultation in which persistence of fever rendered a second operation necessary, and in both of these cases, instead of the lesion being inside of the kidney and due to cortical infection or a carbuncle, the difficulty arose from the fact that thorough drainage had not been established at the previous operation. In both of those cases, extensive suppuration was found at the second operation, in one requiring a nephrectomy and in the other a thorough opening up and drainage of the retained pus which was pocketed deeply about the upper pole.

The point that I wish to bring out is this: that the persistence of fever of a septic type is not always due to the presence of a lesion within the kidney but can well be explained, in certain cases at least, by the failure to secure ample drainage at the first operation.

I want to pay my respects to the presentation of Dr. Colby. It was splendid. I think this is his first attempt before the Society, and he can be congratulated on the very splendid presentation of a very interesting subject.

We have all had experience with these gastro-intestinal disturbances associated with a kidney lesion. I recall one patient who had been under observation and treatment for a period of two or three

weeks for a gastro-intestinal disturbance. He had been given all sorts of treatment for a supposed lesion of the gastro-intestinal tract and, after this prolonged period, including thorough X-ray study and so forth, a plain X-ray plate was made and a stone in the ureter was identified. We were able to get that stone to pass to the bladder with the complete relief of his very marked and pronounced gastro-intestinal symptoms, illustrating, therefore, that a stone in the ureter is sometimes associated—and not only associated but the only cause of symptoms referable to the gastro-intestinal tract.

In another case, the patient was admitted to the hospital at four o'clock in the morning with a typical clinical picture of an acute abdominal lesion—nausea, vomiting, fever, tenderness over the McBurney's point and in the upper right quarter, abdomen markedly distended. The patient was seriously ill.

The routine examination showed the presence of a few red blood cells in the urine. This prevented an onslaught by the general surgeon and the removal of the appendix. That was the diagnosis with which she came into the hospital. Further study showed bilateral renal calculi with a stone low down in the right ureter.

We were fortunate in that case in relieving the symptoms completely by the passing of a catheter beyond the stone and securing drainage of the kidney above. Complete disappearance of the clinical symptoms was obtained by drainage through the catheter, illustrating again the presence of the picture of acute abdominal lesion caused by a lesion in the urinary tract.

DR. K. H. WATKINS (Manchester, England): It is difficult for me to say very much before a meeting such as this, but I think that I might mention one interesting case of a patient with gastro-intestinal symptoms, who came to my notice shortly before leaving England. The patient was, I think, remarkable in this respect, that she was seventy years of age.

She had had, for thirty or forty years, gastro-intestinal symptoms, for which she had had two abdominal operations. Both operations had been without relief of symptoms. About fifteen years later she came for further investigation, and the surgeon who was looking after her asked me to investigate her.

I found that she had a right-sided hydronephrosis, chiefly extra-

renal in type. This patient was operated on and found to have one of those hydronephroses which are commonly described as due to an aberrant renal artery. The kidney was removed rather than attempt conservative surgical procedure, in view of her age.

I mention this case, because it is interesting in view of the patient's age and length of history.

DR. VINCENT J. O'CONOR (Chicago): I was interested in presenting these two patients in whom it seemed to me the diagnosis was quite clear—at least reasonably so—of carbuncle before operation. I was interested in the possible remarks of members of this Association on whether or not in these instances of very large carbuncles, with a history of several months of fever and emaciation, I should have been more conservative and tried enucleation or simple drainage.

Dr. Graves now adds one more case of bilateral renal carbuncle and Dr. Patch added two, making six cases on record, as far as I know. This reminds us, of course, that conservatism must be followed wherever possible. I would have hesitated to leave either of these kidneys in, in view of the size of the lesions. I think if we can get an earlier diagnosis in these patients, before the carbuncular lesion has occupied so much renal tissue, our efforts may be more conservative and the necessity for removing the kidney less frequent.

In regard to Dr. Deming's patient: I would not feel, from what I know of carbuncle, that his case would fit as a carbuncle of the kidney. I would rather feel that it was a case of chronic multiple cortical abscess. We have in the literature only two records of more than one carbuncle in the same kidney. I would rather classify his case as multiple chronic cortical abscesses and not the massive suppurative lesion we regard as carbuncle.

DR. FRANK S. PATCH (Montreal): I am very much indebted to Dr. Fowler for commenting on the fact that I was wise in not exploring the kidney in the case of perinephritic abscess which I opened. While I am against too extensive exploration at the time of the operation, it does not, however, relieve us from the responsibility of a subsequent study, particularly if the symptoms persist, to find out the exact etiologic factor for perinephritic abscess. Not

only do perinephritic abscesses occur from renal lesions but from lesions far away from the urinary tract.

Permit me also to say a word on Dr. Colby's paper, on which I am glad to add my word of congratulation, on the great wisdom in making a full study of our patients.

One sees frequently cases which have been operated upon by general surgeons, without a urologic study having been made. Most of us have had not a few such experiences, where grave error has been made in not making a full urologic study. This might be made the basis for a very excellent paper on the occurrence of renal lesions in gastro-intestinal diseases.

We ought to be very careful, when we accuse the general surgeon of neglect, that we do not leave the same mote in our own eye, as we are just as much called upon to make a full physical examination of our patients as the general surgeon is to make a urologic study in his cases.

I recall, in this connection, a series of three cases of perinephritic abscess, in which the urologic study, after the drainage of the abscesses, showed that the origin of the paranephritides, as they turned out to be, was in the intestinal tract. A fuller study revealed carcinomata of the colon. In one case the diagnosis was made by the appearance of tissue in the process of drainage, the pathologist's study showing it to be a colloid carcinoma of the colon.

Just as the general surgeon in his gastro-intestinal cases should not forget to investigate the kidney, so we in our urologic examination should not forget there is an intimate association between the kidney and sometimes far distant parts of the body.

DR. FLETCHER H. COLBY (Boston): I would simply like to thank the members for their very warm welcome and kind discussion of my humble first attempt. My own viscero-visceral reflex has now subsided, having given my paper, and I am going to enjoy the meeting.

SQUAMOUS CELL TUMORS OF THE KIDNEY ASSOCIATED WITH STONE

WITH REPORT OF TWO PERSONAL CASES

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If kidney stones are not removed, secondary infection, urinary obstruction and destruction of the renal parenchyma not unusually develop. But another element, not so generally known or recognized, may also enter into the consideration of surgery in these cases, i.e., the prevention of cancer. Cancer, it is true, is observed in association with stone in only a small number of cases; but there is a definite, clear cut group in which methods could be successfully employed which would obviate its occurrence.

There are some pertinent observations regarding the association of calculi with cancer. As W. J. Mayo[6] writes: "Cancer does not appear in sound tissues. Investigation of the various theories of the causation of cancer shows that the one provocative agent which remains unchallenged is chronic irritation." He states further: "Concerning cancer of the interior of the body, we have less definite proof of the causative factors, but cancerous gall bladders usually contain stones." Graham[2] states: "Concerning methods of prevention of cancer, the most outstanding fact is that carcinoma of the gall bladder in the great majority of cases is associated with gall stones. Almost all of those who have studied this question believe that the evidence is overwhelming that when calculi are present they have preceded the development of the carcinoma. They should, therefore, be considered as being a definitely precancerous lesion and should be removed before the development of cancer."

The same association also appears to hold true in regard to renal stone and certain types of malignant tumors of the kidney. Not infrequently in cases of renal tumors the history suggestive of malignancy is of comparatively short duration, while symptoms of stone or infection have been present for many years. In 108 cases of associated renal calculi and malignancy collected by Martin and Mertz[5] the symptoms of stone averaged nineteen years in dura-

tion; the symptoms suggestive of malignancy averaged about five months.

Etiology.—Hallé[3] was one of the first to note that epithelial transformation of the mucosa of the urinary passages resulted from chronic inflammation, either simple or due to irritation, from calculi; indeed, typical squamous cell tumors (with all the characteristics presented by this condition on the cutaneous surface) are occasionally found in the genito-urinary tract. Such squamous cell tumors are found in the kidney itself, either confined to the pelvis or involving the entire organ, and are usually associated with calculi. The presumption is strong that the irritation arising from the calculi is the proximate cause of the cancer. I wish to invite particular attention to this special class of tumors because their insidious onset and high mortality make their recognition in the early stages a life-saving procedure.

Course and Incidence of the Disease.—A large percentage of cases of squamous cell tumors of the kidney have a long-standing history of trauma and infection; at times the early history suggests stone formation. Oraison[8] reported the case of a woman, aged fifty years, whose symptoms of renal trouble started with trauma at twenty-four years of age; for the ten years preceding her operation, she had almost constant pain of a type suggesting kidney stones. At operation a squamous cell tumor of the kidney was found, together with many stones; the largest weighed 107 grams. Thomson-Walker[10] reported the case of a man aged sixty-three who had passed calculi at intervals for twenty-seven years. Recently he had had severe attacks of pain which led him to seek relief. A squamous cell tumor of the kidney, together with a large, rounded calculus, was removed. Darmady[1] recently reported a case of squamous cell carcinoma of the renal pelvis operated in 1930, in which hydronephrosis was present twenty-eight years before. The size, weight, and striking lamination of a calculus removed at operation indicated that the latter had also been present for a considerable number of years. Of eleven collected cases considered by Wells[11] as definite squamous cell carcinomas, six had stones. In 1924, five cases of squamous cell tumors of the kidney were reported from the Mayo Clinic[9]; in four of these cases large stones were found. In the fifth case X-ray evidence suggested that stones

were present although the large, solid, fibrous tumor was not completely sectioned in a search for calculi. One of the Mayo Clinic patients, a man aged fifty-four, complained of attacks of right renal colic and intermittent hematuria of twelve years' duration. Recently the pain over the kidney had become more severe and he had lost weight. At operation a large, solid kidney was removed; the mass was composed entirely of squamous cell tumor tissue in which were embedded numerous fragments of a hard, black irregular stone. In a second case in the same series, the patient, a man aged sixty-four years, had had attacks of abdominal pain, starting nineteen years before; for sixteen years he had intermittent attacks of hematuria. At operation a squamous cell tumor of the kidney was found; the kidney also contained a number of large, irregular stones. In a case reported by Menetrier and Martinez[7] the patient, a woman aged forty-nine, had right-sided renal pain for five years. At autopsy a squamous cell tumor of the right kidney was found; the kidney also contained a number of stones, the largest of which was 7×3 cm. in size. In most of these cases the histologic appearance of the tumor, the extensive, rapidly growing metastases, and a quickly fatal termination suggest a comparatively short duration of tumor growth.

Diagnosis.—There are no definite symptoms suggesting this type of growth. Bleeding is comparatively rare, differing from papillary growths of the renal pelvis. In some cases distention of the renal pelvis and the size of the tumor mass is amazing, usually the result of a gradual, slow occlusion which often is almost painless. At times the pain which the patient has had intermittently for years increases and is more persistent, or it becomes constant, suggesting a change in the pathologic conditions present. Not all cases are preceded by long-standing symptoms suggestive of infection or stone formation. In several reported cases the finding of a distended pyonephrotic kidney which presented itself as a large abdominal mass was the first sign of trouble. Of course, in cases without definite symptoms any preventive surgery is out of the question, but cases without pain or signs of calculi form a comparatively small group; the majority giving a history of some long-standing lesion of the kidney, which might readily have been relieved by surgery.

Prognosis.—Once tumor formation has occurred, the outlook for the patient is very poor. Four of the five patients reported from the Mayo Clinic died during the first four months. The fifth was alive six months after operation. In a series of cases reported by Kretschmer,[4] there were eight nephrectomies for squamous cell carcinoma of the renal pelvis. Five patients died at operation or shortly afterward, and the remaining three developed extensive metastases not long after the operation. In almost all of the individual cases reported in the literature it is stated that death or metastasis resulted very shortly after operation. It is a rapidly fatal condition; prevention by early removal of irritative factors is the only hopeful treatment.

PERSONAL CASES

In the following two cases the patients were both women who gave a history of long-standing kidney trouble. In both cases the tumor was of such a rapidly growing malignant type that it is improbable that it was present for more than a relatively short time:

Case 1.—A woman, aged fifty-seven, complained of chills and fever, general malaise and protrusion of her lower abdomen. Eight years ago her thyroid had been removed; on microscopic examination it was found to be tuberculous. Seven years ago physical examination revealed a large left kidney and she was told that she had kidney stones. Five years ago she felt physically exhausted and had a nervous breakdown. She consulted an osteopath who told her she had a tumor of the abdomen. She noticed the mass at the time, thought little of it, and does not know whether it has increased in size during the last five years. She has had several short attacks of frequency and dysuria but never any hematuria. Ten days ago she developed chills and fever; since then she has passed only small amounts of urine. On examination it was found that the left side of the abdomen bulged markedly. Palpation revealed a painless, rounded, cystic, movable mass about 20 cm. in length extending from the left iliac crest to the costal margin and projecting across the midline of the abdomen. The right kidney could not be felt but there was some tenderness in the renal area.

The bladder urine contained pus and blood; the intravenously injected phenolsulphonephthalein return was 40 per cent; blood urea content and hemoglobin were normal. Roentgenographic examination of the kidney, ureters and bladder revealed an ovoid shadow 1×2 cm. in size in the region of the lower right ureter; in the region of

the left kidney there was an irregular shadow 3 cm. in size; the outline of what appeared to be a large cystic kidney could be made out surrounding the shadow on the left. Plates taken of the chest revealed nothing abnormal.

At cystoscopy ureteral catheterization was done; the lower right ureter, in the region of the ovoid shadow, was almost completely obstructed, but after extensive manipulation a small ureteral catheter was passed by this area to the right pelvis, and about 30 c.c. of blood-stained urine withdrawn. No secretion was observed coming from the left side during ten minutes. A ureteral catheter met with an impassable obstruction in the region of the left uretero-pelvic juncture; no fluid was obtained through this catheter. Twenty-one per cent of phenolsulphonephthalein was obtained from the right kidney in fifteen minutes. A roentgenograph taken after the insertion of the ureteral catheters, which were shadowgraphic, revealed that one passed over the small shadow on the right; the other extended up to the region of the larger shadow on the left. The patient's temperature, which was somewhat elevated, dropped to a normal level several hours after the insertion of the ureteral catheters; the catheter was left in the right ureter for three days. A smooth, somewhat impacted stone was then removed through a low, right rectus incision, following which the patient had an uneventful convalescence. Three months later the left kidney was removed through a postero-lateral incision. The kidney was thin-walled, markedly distended and lobulated. She recovered from the immediate effects of the operation but died two months later.

Pathologic Examination.—The kidney was composed of a hydronephrotic cystic shell measuring $22 \times 11 \times 11$ cm. The walls were very thin, about 1 to 2 mm. The surface was slightly granular and the surface lobulations were over-emphasized due to distention with fluid of the portions in between. Near the hilus were several smooth, hard nodules 1 cm. in diameter. In several areas small nodules could be seen and felt through the kidney surface; these raised the surface of the kidney slightly. On sectioning the kidney sagittally, a large quantity of reddish brown fluid containing soft, necrotic tissue was found. The pelvis and upper part of the ureter were blocked with a firmly fixed, irregular dark stone about 2 cm. in diameter.

The dilated poles of the kidney contained many large nodules from 3 to 4 cm. in size; some were firm and smooth-surfaced, others were softer and covered with papillomatous protrusions. There were also numerous small masses from several mm. to 1 cm. in size. Some of these were soft and could readily be scraped from the surface of the wall, while others were definitely embedded in the wall. The intervening mucosa in many areas was gray white, thickened and roughened in character.

Sections of the tumor revealed atypical epithelial cells of transitional

stratified type. There was only moderate hyalinzation; the bulk of the growth was composed of rapidly growing, irregular cells, although in several areas the tumor formation could be traced directly from the squamous-cell lining of the pelvis adjacent to the growth. In several places between the tumor masses there were areas of leukoplakia. Many large, atypical mitotic figures were seen. There was marked irregularity in size, shape and staining qualities of the cells, and in some areas very large cells were seen with deeply staining nucleoli.

Pathologic Diagnosis.—The growth was a squamous cell carcinoma of a high degree of malignancy.

Necropsy revealed numerous metastases. Both lungs contained many small nodules. The left kidney pouch was filled with large retroperitoneal glands. The right adrenal was almost completely replaced by grayish white tumor. The left adrenal was small and surrounded by tumor. Both the head and tail of the pancreas were invaded and the liver contained so many various sized masses that it was markedly irregular in size and shape. The largest nodule in the liver was 6 cm. in diameter. No alveolar arrangement nor definite squamous cell differentiation was found in the secondary nodules.

Case 2.—A woman, aged sixty-seven, came for treatment of an abdominal tumor and a goiter. She has had a goiter since she was twelve years of age, which gradually increased in size. During the last six months she lost thirty-five pounds in weight. She first noticed a lump in her abdomen two years ago. It had grown gradually since then and apparently centered on the right side. She had a dull, constant, nonradiating pain under the right costal margin. She complained of moderate nocturia but no other urinary symptoms; there has never been any gross hematuria.

Physical examination revealed a diffuse nodular goiter which was apparently non-toxic and caused very little disturbance. There was a large, movable, rounded, nodular mass filling the entire right upper quadrant of the abdomen, extending over the midline and down to the right iliac crest. It was not tender and could be moved without causing pain. The urine contained pus, blood and albumin. The phenosulphonephthalein return was normal. The hemoglobin was 58 per cent and the red blood count three and a half million. A roentgenographic examination revealed the irregular outline of a large mass occupying the region of the right kidney. There were numerous shadows suggestive of renal stones and a partially calcified rounded structure near the lower edge of the mass.

Cystoscopy revealed a normal appearing bladder. No urine came from the right ureteral orifice in seven minutes. The secretion from the left side was apparently normal. A catheter inserted in the right ureter met an impassable obstruction near the upper end of the ureter. Twenty-five per cent of phthalein was returned in fifteen minutes

through a catheter inserted into the left kidney pelvis. A small amount of sodium iodide was injected into the right kidney and was seen in the roentgen-ray picture as an irregular, contracted area at the base of the calcified area seen in the original roentgenogram.

An exploratory examination was made through a small lateral incision. A large cavity was opened and about ten ounces of thick pus and several small stones were evacuated. The abdominal mass was found to be a tumor of the kidney, the growth having spread from the kidney to most of the surrounding structures; it was much too extensive for extirpation; a section was removed for examination and the incision drained and closed. The patient died one month later.

Pathologic Examination.—The specimen showed a cellular connective tissue framework supporting bands, cords and irregular groups of atypical epithelial cells of stratified squamous type. There was a marked tendency to differentiation with numerous epithelial pearls. Occasional mitotic figures were seen.

Pathologic Diagnosis.—The tumor was a squamous cell carcinoma of a moderate degree of malignancy.

COMMENT

In the above two cases, as in most of the reported cases, it was obviously impossible to state at what time the cancerous condition started. In the majority of cases stones have been present for a long period of time, probably long before the onset of the malignant condition; the early removal of these stones might have prevented the formation of the growth.

Comparison of the excellent results, simplicity of procedure and the low operative mortality following the removal of uncomplicated renal stones with the rapidly fatal outcome after the formation of a secondary tumor justify us in suggesting that the majority of kidney stones should be removed as early as possible; this should be done not only as carried out in the usual case to relieve pain and to prevent the destruction of kidney tissue, but also because in some cases as those described above, it should prevent the formation of a malignant tumor.

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TUMORS OF THE RENAL PELVIS

A REVIEW OF THE LITERATURE AND REPORT OF A CASE

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New growths of the renal pelvis as compared with those of the kidney parenchyma are relatively infrequent. It is estimated that on an average only 5 to 7 per cent of all renal tumors occur primarily in the kidney pelvis. Thus Albarran in 1901 found forty-seven tumors of the kidney pelvis in a series of 625 renal growths. In a collection of 585 cases Albarran and Imbert in 1903 were able to find only forty-two cases that arose primarily in the renal pelvis. Recently Hunt reported on 318 cases; only thirteen were growths of the kidney pelvis. From these reports it is obvious that only a small percentage of kidney tumors have their origin in the pelvis. Of course there are reports showing higher proportions but these are scarce. Thomson-Walker, for example, found twelve cases of tumor of the renal pelvis in a personal series of sixty-six renal growths. Since 1918 there have been ninety-six cases of tumor of the kidney in our Service at the Royal Victoria Hospital. Of these only one was a new growth of the renal pelvis.

Up till the present time there are in the literature about 218 cases of growth of the kidney pelvis. In 1926 Meltzer reported 181 cases, and in 1927 Hunt added seven more, making a total of 188. Since 1927 about thirty additional cases have been found in the literature.

PATHOLOGY

The types of tumor that arise in the renal pelvis are similar to those that occur in the bladder. Practically all of them are derived from mesodermal tissue. There is also, however, a small number of growths that are of the squamous cell type. Whether this is due to metaplasia or to a developmental abnormality is not definite.

Ewing classifies the growths of the renal pelvis as follows:

1. Papilloma.
2. Papillary epithelioma.
3. Squamous cell carcinoma.
4. Alveolar carcinoma.

Thomas and Regnier follow Ewing's classification rather closely but add in addition the so-called connective tissue tumors. The latter is a very small group and includes the adenoma, fibroma and sarcoma.

Papilloma.—About 40 to 50 per cent of all tumors of the renal pelvis belong to this class. They are usually multiple and appear as villous or wart-like growths similar to those found in the bladder. When placed in water they become somewhat branched and elongated, and very closely resemble seaweed. Occasionally the growth has an extensive distribution and may involve the ureter, the bladder and even the ureter on the opposite side. Often there is one large tumor with several smaller ones surrounding it. Frequently these growths are associated with salty incrustations and even with definite calculi. These papillomata are all very vascular and bleed easily. This accounts for the marked hematuria that is usually the outstanding symptom in the disease.

Microscopically the picture is typical. The structure of the papilloma is simple and uniform. It consists of a series of branching clusters of stroma covered by many layers of transitional epithelium. The stroma usually is made up of fine branching blood vessels which are in close association with some connective tissue and smooth muscle fibres. The tumor cells are cubical, cylindrical or elongated, and there is present round cell infiltration. The base of the tumor is free from any invasion of the tumor cells.

These growths are usually quite benign but have the tendency, like the simple papillomata of the bladder, to become malignant. They also have the quality of producing transplants along the entire course of the ureter and even down to the bladder.

Papillary Epithelioma.—This group comprises about 20 to 30 per cent of the growths of the renal pelvis. These tumors are also wart-like in character but appear more compact and involve a greater area than the simple papillomata. The villous processes are usually not so long or branching, and very often show areas of ulceration. Here, too, the growth may involve the entire ureter and even the bladder.

In the early stages of the growth there is definite evidence of involvement of the submucosa, and later the renal parenchyma is encroached upon. In advanced cases there is usually distention of

the renal pelvis and the presence of multiple cysts in the cortex of the kidney. These tumors are also extremely vascular and bleed very easily.

Microscopically the tumor cells are found to have invaded the base of the tumor and the submucosa. In some growths one finds areas of benign and malignant cells side by side suggesting a transformation of a benign to a malignant tumor.

Fig. 1. Photograph of the pyelogram in the case discussed. Note the absence of the upper calices and the marked filling defect in the pelvis.

Alveolar Carcinoma.—This form of tumor is probably a far advanced papillomatous growth which has lost its papillomatous character. It now assumes an alveolar or scirrhous type of growth. These tumors are large, infiltrating, very malignant and form metastases very readily.

Squamous Cell Carcinoma.—This is a small group but a fair number of cases have been reported in the literature. Kretschmer found two cases in a series of forty-three non-papillary growths of the renal pelvis. In addition he found eleven cases of pavement

epithelioma, one epidermoid carcinoma and four epitheliomata, all showing a tendency to form epithelium resembling the skin.

Scholl and Foulds in 1924 have reported five cases. Recently Bowen and Bennett have also reported such a case. All the authors emphasize the importance of previous infection as a causative agent. Leukoplakia with calculi also seems to play a part as several of the cases described have been associated with these conditions. Apparently the epithelium of the renal pelvis is capable of epidermization. These tumors are usually quite large and the squamous qualities are quite pronounced. There is often pronounced hornification with the presence of many epithelial pearls. These growths are definitely less vascular than the papillomata. They grow rapidly and involve the renal parenchyma and the surrounding tissues.

Connective Tissue Tumors.—Histoid growths of the pelvis are extremely rare. They include the fibroma, adenoma and the sarcoma. Plant, in 1929, reported a diffuse adenoma of the renal pelvis. Boross, also in 1929, described a case with a fibroma of the renal pelvis.

Metastases.—The simple papilloma is benign but has the inherent quality of spreading. This often results in very extensive growths involving the kidney parenchyma, the ureter, the bladder, and even the ureter on the opposite side.

The papillary epithelioma is a malignant growth and very often takes the form of an infiltrating carcinoma. Metastases are found in the adrenals, peritoneum, liver, lungs, bones and lymph nodes.

The squamous cell and the alveolar carcinoma are both highly malignant. Metastases usually occur early and may involve any organ of the body.

ETIOLOGY

Age Periods.—The majority of the cases on record have occurred between the ages of forty and sixty years. The youngest patient reported was two years of age (Kananka); the oldest patient, eighty-two years of age.

Sex.—Males seem to be affected more often than females. In a large series of cases reported by Thomas and Regnier, 62 per cent of them occurred in males.

Infection.—Chronic infection of the renal pelvis seems to play a prominent part in these tumors. Many of the cases reported have had a history of renal infection, calculi, or of both. As a result several of the authors emphasize the dangers of neglecting infections and stones in the kidney.

Scholl and Foulds have reported five cases of squamous cell carcinoma of the renal pelvis, four of which had calculi and infection.

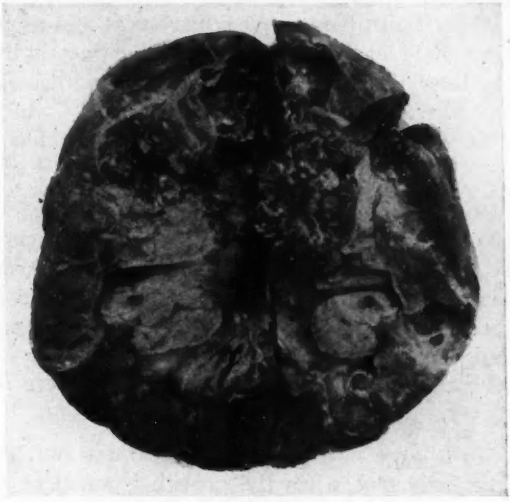

Fig. 2. Photograph of the specimen. Note the papillary growth involving the upper part of the pelvis and extending towards and into the cortex.

Kretschmer, in 1917, reviewed forty-three cases of non-papillary growths of the renal pelvis; of these eleven were associated with calculi. Bowen and Bennett have also reported a similar case just recently (1930).

Congenital Abnormalities.—There does not seem to be any special predisposition to new growths in the congenitally abnormal pelves. There are, however, a few cases on record. Thomas and Regnier mention a case in a horseshoe kidney. Roberts, in 1928, described a case in a double ureter and pelvis. The tumor was present in the lower pelvis.

SYMPTOMATOLOGY

Hematuria.—The most outstanding symptom in tumors of the renal pelvis is hematuria. In a large series of cases studied, Thomas and Regnier found that 67 per cent of the patients had blood in the urine at one time or another in the course of the disease. Moreover, in half the number of the cases the first symptom noticed was bloody urine. In their own personal series (five cases) hematuria was the outstanding symptom. Meltzer states that hematuria is present in 70 per cent of the papillary growths and in 50 per cent of the non-papillary growths. An interesting fact is that several patients have intermittent attacks of hematuria with long intervals of freedom. There are a few cases on record in which patients have been free from hematuria for periods from ten to twenty years.

Pain.—This symptom is not a constant one. At times a patient will complain of a dull ache in one or other loin. Occasionally there will be a typical renal or ureteral colic. This is undoubtedly due to the passage of a small transplant or blood clot down the ureter. Rather severe pain may also result when an obstruction occurs at the uretero-pelvic angle causing a hydronephrosis or a hematonephrosis. Finally, it must be remembered that there may be no pain whatsoever.

Tumor.—In a large number of cases no mass can be palpated. This is particularly true when the growth is small or when it is spreading towards the upper pole of the kidney. The most common cause of a palpable tumor is probably an associated hydronephrosis or hematonephrosis due to some obstruction. When the latter is relieved as a result of the passage of a small piece of growth or blood clot the tumor mass very often disappears.

Passage of Tissue.—Many patients with growths of the renal pelvis, particularly papillomata, will volunteer the information that they are always passing small pieces of tissue covered with blood clot. These fragments of tumor resemble very closely those that are passed in cases of bladder tumor, and very often such a diagnosis is made.

Loss of Weight and Strength.—These are late symptoms and occur when metastases are present.

Urinary Symptoms.—Frequency, urgency and dysuria occur only when the bladder becomes irritated by blood clots or pieces of tumor.

DIAGNOSIS

There are no symptoms or signs that are pathognomonic of a tumor of the renal pelvis. In order to arrive at a possible diagnosis all available data are to be studied. The history, physical findings, urinary studies and, finally, cystoscopy with pyelography, are all essential in the diagnosis.

Cystoscopy and pyelography are undoubtedly our greatest aids. When the growth has not extended into the bladder the latter viscus appears perfectly normal. Very often, particularly during an attack of hematuria, blood may be seen escaping from one or other ureteral orifice. This sign will immediately draw your attention to the diseased side. If the ureter is not obstructed by the growth, the catheter will pass easily to the renal pelvis and bloody urine will be collected. At times, however, the growth involves the ureter and, as a result, the catheter may be obstructed.

Retrograde pyelography is to be performed in all cases. If a tumor of the renal pelvis is present there is a definite filling defect but that is not sufficient for a diagnosis. It must be remembered that a tumor of the renal parenchyma or a blood clot in the renal pelvis may give identical pictures.

In the differential diagnosis, renal tuberculosis, acute pyelonephritis, renal calculi and tumors of the renal parenchyma are to be excluded.

PROGNOSIS

Although the simple papilloma of the renal pelvis is a benign growth yet clinically it is potentially malignant. It has the property of forming transplants in the ureter, bladder, and even in the opposite ureter. It is for this reason that nephrectomy and complete ureterectomy with excision of the ureteral orifice is advocated. There are cases on record that were first subjected to a nephrectomy and later had a complete ureterectomy on account of recurrence. Thomson-Walker reports two such cases in 1929.

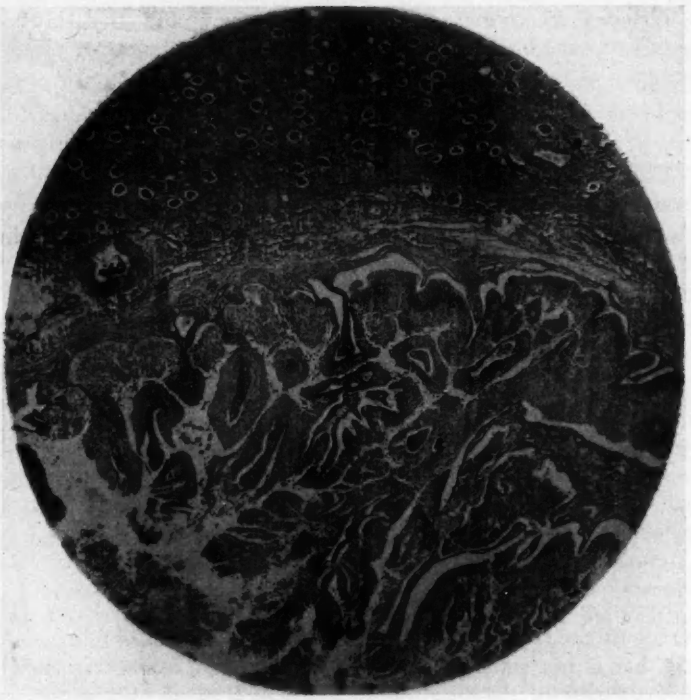

Fig. 3. Microphotograph (low power) showing a definite papillomatous growth. Note evidence of degeneration of some of the papillary outgrowths.

The malignant papilloma has a better prognosis than the other malignant growths of the renal pelvis. Metastases occur late and are usually not widespread.

The most malignant tumor of the renal pelvis is the squamous cell carcinoma. It metastasizes early and very extensively. The results are very poor even with early treatment. Kretschmer reports on eight cases. Five patients died at operation and three very soon after. Scholl and Foulds operated on five patients: one was dead eight days after operation; three were dead during the first four months and only one was alive and apparently well six months after operation.

The alveolar carcinoma is also a very malignant growth. It metastasizes early and may involve any organ or tissue in the body.

TREATMENT

On account of tendency of tumors of the renal pelvis to extend down the ureter and even to the bladder, the treatment of choice today is nephrectomy and complete ureterectomy. In the past nephrectomy with or without partial ureterectomy was performed. This procedure was found to be too conservative, for several of the patients returned later with involvement of the ureter and even the bladder.

Hunt and others are even more radical. They advise nephrectomy, complete ureterectomy and segmental resection of that part of the bladder that includes the intramural portion of the ureter.

Several authors advise the use of deep X-ray therapy or radium after the removal of the growth.

CONCLUSIONS

1. New growths of the renal pelvis are still of sufficient rarity to be of extreme interest to the urologist.
2. The disease is very often wrongly diagnosed.
3. The diagnosis may be made from the history, symptoms, urinary findings, and, finally, from cystoscopy and pyelography.
4. The treatment consists of nephrectomy and complete ureterectomy.
5. The prognosis even in simple papilloma is to be guarded.

CASE REPORT

The following is the record of the patient with such a growth:

J. A. T., male, aged seventy-one years, was admitted to the Urological Service at the Royal Victoria Hospital on December 30, 1931.

Complaints were (1) painless hematuria and (2) frequency of urination.

The patient was perfectly well until October 15, 1929, when following a long motor trip he began to pass bright red blood in the urine. There were no other urinary symptoms such as dysuria or frequency of urination. The bleeding lasted off and on for about one month and then disappeared. There was no further hematuria until October, 1931. The blood was always well mixed with the urine, and there was in addition some frequency of urination: day 5-6; night 1-2.

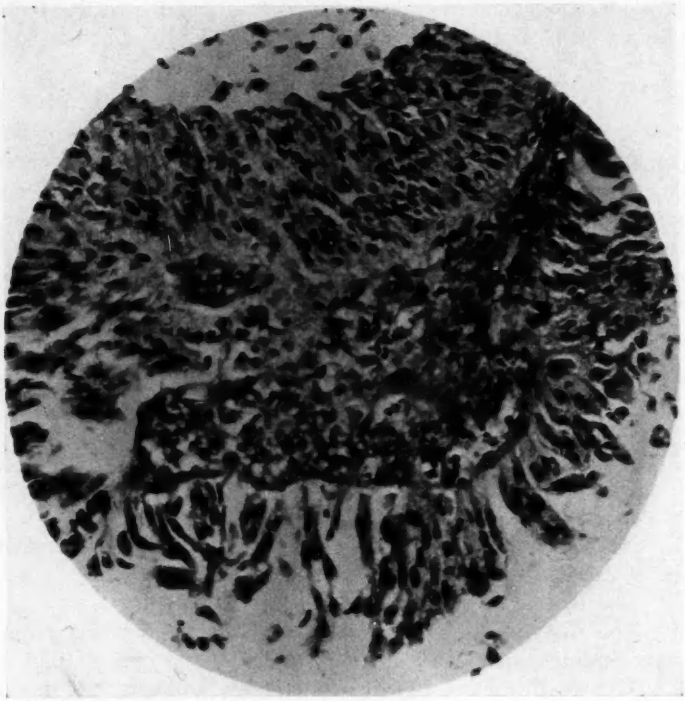

Fig. 4. Similar to Figure 3 (high power). There is definite involvement of the parenchyma, with stratified transitional cells.

There were no other urinary symptoms except the passage of small pieces of tissue. There was never any pain in either loin. The patient's private physician examined one of the pieces of tissue and found cells which resembled very closely those that are found in papillary carcinoma of the bladder.

The patient had the usual childhood diseases; typhoid fever in young adult life; no other serious diseases. The mother died of pulmonary tuberculosis.

Physical examination showed the patient to be a well developed and nourished white male; head, normal; neck, bilaterally enlarged submaxillary glands; nose and throat, negative; respiratory system, negative. There was a moderate degree of arteriosclerosis, and a hypertension ranging between 178 and 200 systolic and 108 and 110 diastolic. The heart was moderately enlarged, and the aortic second sound was

markedly accentuated. Electrocardiograph showed a left sided preponderance; regular rate; normal conduction time. The liver was enlarged, the edge was felt two fingerbreadths below the costal margin. No other organs except the lower pole of the right kidney were palpated.

The nervous system and the skin and locomotor system were negative upon examination. The kidneys revealed no costo-lumbar tenderness on either side. The lower pole of the right kidney was palpated. No further organs or masses were palpated on either side. There was no tenderness or masses along the course of either ureter. The bladder showed no suprapubic distention or tenderness. The penis was normal. There was no discharge from the urethra. A soft rubber catheter F. No. 14 passed easily to the bladder. Residual urine was iv drams. The scrotum and contents were normal except for slight varicosity of pampiniform plexus on both sides. Rectal examination revealed prominent external hemorrhoids, sphincter tone good. The prostate was moderately enlarged, glandular, smooth, not fixed, not tender. Seminal vesicles were not palpated.

Laboratory findings were as follows: Urine: smoky reddish, acid, 1.018; albumin, trace; sugar, none; red blood cells +++; white blood cells, a few; urates; epithelial cells. The introduction of 1 c.c. phthalein intramuscularly resulted as follows: first hour, 35 per cent; second hour, 25 per cent, making a total of 60 per cent. Blood Wassermann test was negative.

Cystoscopy was performed, a F. No. 24 instrument being easily introduced. There was slight intravesical enlargement of prostate. Bladder mucosa was normal. No tumor or foreign body was seen. Both ureteral orifices were normal in contour and position. Cloudy reddish urine was seen coming from the right ureteral orifice. Normal urine was seen coming from the left ureteral orifice. Both ureters were easily catheterized to the renal pelves and specimens obtained.

	Right	Left
Macros:	bloody	clear watery
Vol:	8 c.c.	20 c.c.
Urea:	0.0035	0.0035
Micros:	R.B.C.++++	R.B.C. rare
	W.B.C. occasional	Epith. cells

X-ray with catheters in position showed catheters in normal position. The right kidney shadow was large and indefinite. The left kidney shadow was outlined; no shadows suspicious of stone were seen. Right pyelogram, with 8 c.c. 12 per cent sodium iodide, showed a definite filling defect of the upper portion of the pelvis (Fig. 1). Left pyelogram, with 4 c.c. 12 per cent sodium iodide showed a relatively normal renal pelvis.

Diagnosis was malignant growth of the right kidney. In view of the history of passing pieces of tissue, the possibility of a papilloma of

the renal pelvis was considered. Nephrectomy and right ureterectomy were done on January 2, 1932.

The pathologic report was as follows: The right kidney was slightly larger than normal, split open showing a papillary growth which involved the upper part of the pelvis. This growth appeared well demarcated but had compressed the medulla and cortex in this area with the formation of a filbert sized cyst. The remaining portion of the kidney showed considerable peripelvic fat, and definite markings and coarse irregular lobation under the capsule (Fig. 2).

Through microscopic examination sections showed a papillomatous growth of stratified transitional cells similar to that encountered in the bladder and apparently taking origin in the pelvis of the kidney. It had invaded the parenchyma, which was compressed and, while fairly well demarcated, showed evidence of malignant infiltration. Section taken through a small pin-head greyish nodule in the cortex showed it to consist of a growth similar to that described above. There was also considerable metastatic involvement in the cortex in this area (Figs. 3 and 4).

Anatomical summary was transitional celled papilloma of the pelvis which has become cancerous.

The patient had an uneventful convalescence and was discharged as cured on February 1, 1932. He was reported well on May 4, 1932.

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PATHOLOGIC AND CLINICAL DATA CONCERNING POLYCYSTIC KIDNEY

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Polycystic disease of the kidney is discovered often enough on surgical exploration, or at necropsy, and occasionally on clinical examination, to warrant review of the pathologic and clinical data which may be of aid in its recognition. When polycystic disease is overlooked, it may be the cause of considerable confusion and may even lead to serious consequences. If, on the other hand, it is recognized, and thorough clinical examination is made, a fairly definite prognosis can be given, and the care of the patient may be materially altered.

The data in this article were collected from 193 patients observed at The Mayo Clinic, concerning whom a diagnosis of polycystic kidney was made. Many of these patients returned for subsequent examination, and it was possible to corroborate clinical data previously obtained. Included in this group were ninety-four patients who were operated on for various renal complications occurring with polycystic disease, or whose renal condition was discovered in the course of operation for other abdominal conditions. Records of necropsy made at the clinic were available in nine cases and operative specimens were obtained in ten cases. Thus, histologic studies were possible in nineteen cases. Moreover, the findings at postmortem examination, in many of the cases in which death occurred after the patients had returned to their homes, were available.

The incidence of congenital polycystic kidney found at postmortem examination at The Mayo Clinic was nine in 9,171 cases, or a ratio of 1:1019. The incidence noted clinically was 193 cases in 680,000 registrations, or one case in 3,523.

PATHOLOGIC ANATOMY

On cross section of the polycystic kidney the cysts are seen to be distributed throughout the renal structure, in contradistinction to the localized acquired cysts. Regardless of the number and the age

of the cysts, the general contour of the kidney is maintained throughout, which may be regarded as evidence against the hypothesis that the cysts are neoplastic. The cysts contain fluid, which often is mixed with blood, and which may vary in color from pale straw to dark brown or black. The consistence of the cystic content ranges from that of an aqueous fluid to tenacious, colloid material. In an advanced case, the cysts lie adjacent to one another, occupying the entire renal structure. The walls of the cyst are usually thin, but the pressure within the cysts is sufficient gradually to destroy the renal parenchyma, which becomes of a fibrous nature. In rare instances a cyst adjacent to the pelvis will rupture into it, with resulting infection. The diameter of these cysts varies from less than a millimeter to many centimeters. Isolated cysts frequently increase to such size that they cause mechanical irritation. Infection originating within the cysts may give rise to perinephritic abscess or to diffuse renal infection.

As the cysts increase in size and multiply, the pelvis is encroached on and becomes deformed. The calices may become elongated, and broadened, while others are abbreviated or even obliterated. Polycystic kidneys are occasionally enormous; in our series, the largest were found in a man, forty years of age, who died of uremia. Postmortem examination disclosed congenital polycystic kidneys each weighing 7,284 gm. (approximately 17 pounds). The normal weight of a kidney is 300 gm. The left kidney measured 34 by 20 by 12 cm.; the right, 33 by 19 by 12 cm. Numerous adhesions bound the intestines to the kidneys.

Coincident cystic disease of the liver probably occurs more frequently than clinical data might suggest. Of the nine cases of polycystic renal disease in which postmortem examination was performed, associated cystic disease of the liver was found in four, and of the pancreas in one. Cystic disease of the liver is usually confined to limited portions of the organ, and is seldom the cause of symptoms suggestive of hepatic disease. Cysts of the liver do not usually attain large size, although in one case observed the cysts protruded to such an extent from both sides of the liver that they were confused with polycystic renal enlargement. Hepatic cysts are occasionally observed without any accompanying renal involvement. Other organs which have been reported to be involved in cystic degeneration are the ovary, broad ligament, uterus, blad-

der, and epididymis. Cystic degeneration is frequently associated with developmental errors of other organs. This associated cystic degeneration would indicate a single origin of the condition, and strengthens the belief that it has a congenital basis.

Polycystic kidney is always bilateral in the adult. Even though, on intra-abdominal palpation during the course of operation, one kidney does not seem to be involved, it will subsequently prove to be cystic. In our series, in only three cases did renal enlargement appear to be unilateral at surgical exploration, and in one of these, enlargement of the other kidney developed subsequently. Clinical and surgical reports of unilateral polycystic kidney are of little value unless confirmed by careful postmortem examination.

The relation of polycystic kidney to the condition of solitary cyst of the kidney is not entirely clear. In cases of solitary cyst, however, the cysts are usually single, or limited in number, and occur unilaterally. Multiple cysts are occasionally observed confined to one region of a kidney, which may resemble in size and appearance a kidney that is the site of polycystic disease. The cysts are usually confined to one pole of the kidney, while the remaining renal tissue is normal. The condition is probably of inflammatory origin, although the possibility of its congenital nature is not excluded. According to our observation, this condition is unilateral. It is very probable that it has been confused with polycystic disease in those cases in which polycystic kidney has been reported as being unilateral. Other types of cysts are those frequently found in arteriosclerotic kidneys, and the simple serous cysts that are found in kidneys that otherwise are apparently normal. These cysts are probably due to inflammation or obstruction, and occasionally may assume large proportions. Hydatid and dermoid cysts occur very infrequently and offer little difficulty in identification.

Histology.—Histologic study of polycystic kidneys reveals the cysts to be lined usually with a low, flattened type of epithelium; occasionally proliferating areas are seen in which tuft-like papillary bunches collect, which often resemble glomeruli. The walls of the cysts are surrounded by a peculiar, pale-staining connective tissue, which fills the spaces between the cysts where the renal parenchyma has been completely destroyed. The content of the cysts is usually an albuminous material containing epithelial cells. Occasionally blood

is found. Cholesterol crystal clefts and phagocytic cells containing fat particles are noted often. Depending on the degree of involvement, there may be areas of parenchyma, varying from those which appear to be fairly normal, to areas in which all the parenchyma has been replaced by cystic degeneration. Numerous areas of localized lymphocytic infiltration with hyalinization of glomeruli are present.

There is usually marked thickening of the smaller arteries and arteriolar walls. This is a very important factor in the progress of the disease, and may be closely associated with hypertension, which was present in a large number of our cases.

Groups of deeply staining, small round cells in a fetal kidney which is the site of congenital polycystic disease, have been interpreted as cells of an embryonic nature by Davis and others. In adults with arteriosclerotic changes in the kidney there are cells closely resembling these, which are probably lymphocytes.

HEREDITY

The hereditary tendency of polycystic kidney has been noted by many observers, and constitutes one of the chief proofs of its congenital nature.

Crawford has reported an unusual family group as follows: in seventeen of forty members of a family a definite diagnosis of congenital polycystic kidney was made; in two others, the condition was suspected, and in twelve no clinical evidence of the condition could be discovered. Cairns, and recently Fuller, have also reported interesting family records of this condition.

Numerous instances in which several members of a family, or members of a preceding and a succeeding generation were afflicted with this same condition were found in our series of patients. In one case the condition was probably present in representatives of four generations. Two cases were noted in which polycystic kidneys were present in three generations, and five cases in which the condition was observed in two generations. Of interest also are six instances in which two or more members of the same family were found to have this condition. There is apparently variability in the frequency of inheritance in different families. In view of the pronounced hereditary tendency, it would seem logical to consider limitation of progeny. Among the less intelligent, sterilization may well be advocated.

AGE AND SEX

Clinical symptoms seldom appear in the first two decades of life and are unusual even in the third decade. If the lesion is not evident in infancy, it rarely manifests itself before puberty. Impairment of renal function or other lesions are not usually evident until the fourth decade. The symptoms have their onset most frequently in the fourth or fifth decade. Eighty-eight patients, or 46 per cent of our series, were included in this period of life. A large number of patients have no subjective evidence of disease until the sixth and seventh decades. The oldest patient observed in our series completed a normal span of life, namely sixty-nine years, before any symptoms appeared.

Several limited series of patients with polycystic disease have been reported in which the incidence was higher among males than among females. This preponderance of males was not borne out in our larger series: of 193 patients ninety-eight were females, and ninety-five, males. There is, therefore, no difference in the incidence by sex of patients with polycystic kidney.

DURATION OF DISEASE

Of seventy-four patients reported dead, twenty-two (approximately 30 per cent) died within two years following the onset of the first symptoms. Eleven (15 per cent) died in the period between two and four years after their first symptoms appeared. In these two groups, 45 per cent, approximately one-half of the patients, lived less than four years following onset of their first symptoms. The remaining patients lived from five to twenty years, with the exception of two, one of whom lived twenty-three years and the other thirty-six years (Table 1). The average age at death in this group was fifty years. Of the forty-two patients reported living when last heard from, twenty-five had lived ten years or more, and nine had lived twenty years or more. From studies of the renal function, the cardiovascular system, the hemoglobin, and the urine, one may obtain a fair idea of the expectancy of life of the patient.

The length of life will depend largely on the degree to which renal function is maintained, and this, in turn, on the degree of pressure exerted by the cysts on the normal renal tissue. There is marked variability in the incidence and size of cysts. When they

are so numerous as to preclude much residual functioning renal tissue, and unless they remain very small, renal function will gradually diminish. This probably will depend on increase in size of the cysts rather than on the number of cysts. The prognosis for the

Table 1

DURATION OF DISEASE FROM ONSET OF FIRST SYMPTOMS AMONG PATIENTS REPORTED DEAD

Patients	Duration, years	Per cent
14	1	
8	2	29.6
6	3	
5	4	14.9
3	5	
3	6	
5	7	
1	8	16.2
2	9	
7	10	
4	11	
2	12	20.3
0	13	
2	14	
1	15	
1	16	5.4
2	17	
1	18	
2	19	
3	20	10.8
0	21	
0	22	
1	23	1.4
0	24	
1	36	1.4

patient who is in the third or fourth decade of life is uncertain, since evidence of subnormal renal function usually is not marked until the fifth decade. The patient observed in the fifth or sixth decade, who shows no evidence of diminished renal function, usually will live a life of normal length.

CLINICAL COURSE

The clinical picture presented by patients suffering from polycystic renal disease may vary considerably, depending on the stage to which the disease has progressed. The onset of symptoms may be very gradual, or extremely sudden. In cases of gradual onset the kidney may go on to almost complete destruction before any untoward symptoms are noted. As the cystic disease progresses, symptoms caused by renal insufficiency will appear, such as weakness, periods of malaise, headache, and gastric symptoms. Some patients suddenly give signs of renal insufficiency and uremia, and may die in relatively short periods of time. Occasionally, cerebral hemorrhage occurs in cases in which there is hypertension which had previously caused no distressing symptoms. Complications from intercurrent disease may appear as the result of decreased vitality and lowered values for hemoglobin, and may add materially to the rapidity of the patient's decline. With increased vascular disturbance there may be symptoms caused by hypertension. With cardiac failure, which usually appears late, there may be edema and dyspnea.

Patients may be unaware of the gradual, progressive enlargement of the kidneys, which may have extended over many years prior to the onset of the first symptoms. Both kidneys may be found greatly enlarged, without apparent serious injury to renal function or to the cardiovascular system. After a varying period, however, the kidneys become insufficient, the cardiovascular system is impaired, and death will follow as a result of uremia or vascular accident.

SUBJECTIVE CLINICAL DATA

Pain.—Pain referred to the lumbar region, or to an upper, lateral abdominal region is a common symptom, and is often the reason for seeking medical aid. The pain is usually unilateral, and is described as a dull ache, although it may become severe. It may be difficult to ascertain its cause, but in some cases in which there is more or less constant pain it is apparently the result of the excessive weight of the greatly enlarged kidney. In others it might be explained by intrarenal or intracystic pressure resulting from increase in size of individual cysts. Occasionally one or more cysts may become of enormous size and be the cause of considerable dis-

comfort. Mechanical pressure on surrounding organs by these cysts may also be a factor. Complete relief has been obtained in several of our cases by surgical evacuation and destruction of large or hemorrhagic cysts. Some patients obtained relief by lying down; others by supporting the kidneys with abdominal pads. Sudden hemorrhage into a large cyst may be the cause of severe, acute pain. The passage of blood clots, with ureteral obstruction, may also be the cause of acute renal pain. Renal pain may be accompanied by fever and other evidence of acute renal infection, which may be explained by acute infection of one or more cysts, or by ascending pyelonephritis caused by temporary obstruction of a calix.

Urinary symptoms.—Gross hematuria was noted by sixty-six patients, or approximately a third of the total. Microscopic evidence of blood was reported to have been found in the urine of eighty-five patients. Dysuria or frequency in micturition was noted by only 15 per cent of patients.

Other symptoms.—Nausea and vomiting were noted by fifty patients, and were usually due to renal insufficiency. Weakness, usually profound, was present in forty cases.

OBJECTIVE CLINICAL DATA

Weight.—Loss of weight was detectable in 115 cases. Loss of weight amounting to 10 pounds or more was noted in eighty-four of our cases. This sign is probably closely associated with other manifestations of renal insufficiency. The physician should interpret the patient's report of weakness and a marked sense of fatigue of recent origin as usually presaging other evidence of renal insufficiency, and as indicative of a serious prognosis.

Abdominal tumor.—On physical examination, bilateral enlargement was palpable in 151 cases, unilateral enlargement in thirty, and no enlargement in twelve. Although both kidneys are usually markedly increased in size, there is often a decided difference in volume. It is not unusual to find one kidney but little larger than normal, while the other may be several times as large. Failure to determine bilateral renal enlargement on abdominal palpation is a common cause of error in diagnosis, and the lesion is frequently mistaken for renal neoplasm. Other factors, such as fat or mus-

cular abdominal walls, may interfere with clinical recognition of renal enlargement of moderate degree. It is surprising how large the kidney may be and still escape detection in the general physical examination. As the kidneys become enlarged they frequently change their position. They usually assume a lower level and frequently the mistaken diagnosis of simple renal ptosis is made. Occasionally, lateral displacement of one or both kidneys occurs.

Although the tumor is often cystic, on abdominal palpation, particularly if there are several distended cysts on the anterior surface of the kidney, it may appear to be firm and solid. In some cases the irregularity of the cysts can be palpated easily. The kidneys move with respiration in many cases, while in others they become fixed as the result of perirenal adhesions. If, therefore, cystic irregularity and soft consistence are not present, but instead a unilateral, firm, fixed mass is palpated, as often occurs, the erroneous diagnosis of renal neoplasm is easily and frequently made.

Examination of the scrotum revealed the presence of a varicocele of recent origin in several cases. This occurred on the left side, with marked enlargement of the left kidney, and would indicate pressure on the large veins on that side. This, also, might lead to confusion with renal neoplasm because of its frequent occurrence with this condition. Associated congenital deformities were found in several cases.

Hematuria.—Gross hematuria usually occurs at irregular intervals and is of limited duration. It is frequently brought on by violent exercise or jarring. The hemorrhage is usually of considerable degree, and is often accompanied by clots which may cause renal colic. The hematuria is, therefore, similar to that occurring with renal neoplasm, and, if but one kidney is easily palpable, tends to increase confusion with this condition.

Blood pressure.—Although one of us (Braasch) first called attention to the frequent occurrence of hypertension with polycystic kidney in 1916, it has since been a disputed point among clinicians. Bell and Clawson, in 1928, concluded that "the available information is strongly against the view that congenital cystic disease of the kidneys is accompanied by persistent hypertension." This statement is not borne out by our present studies. The blood pressure of 190 patients was noted. Since the average age of our

patients was forty-three years, it would be logical to consider a systolic blood pressure of 145 mm. of mercury or more as an indication of hypertension; a diastolic pressure of 90 or more was similarly considered. Of our patients, 61 per cent had systolic pressures of 145 mm. or more. In a study of the patients reported dead, records showed that 71 per cent had had elevated systolic pressure. In a control group of the same age and sex, made up of patients suffering from chronic pyelonephritis, 26 per cent had elevated blood pressure, and the incidence of hypertension among patients who were less than fifty years of age was 17 per cent. Among the patients with polycystic kidney who were reported dead, 52 per cent of those with hypertension were less than fifty years of age. Similarly, diastolic pressure was found to be more than 90 mm. of mercury in 55 per cent of the cases, and more than 95 mm. of mercury in 47 per cent. This indicates that the basis for hypertension in polycystic kidney is not directly related to age, but has its origin in vascular disease. This would be corroborated by the work of Hinman and Morrison (1924) and by that of Ritter and Baehr (1928), who reported the results of injecting the arterial supply of polycystic kidneys. The latter two workers found a decrease in the size of the small arteries and the arterioles, and pointed out the similarity between the clinical course in cases of malignant hypertension and late glomerular nephritis with that of polycystic kidney.

Cardiac hypertrophy.—Enlargement of the heart was noted clinically in 17 per cent of our cases, and accentuation of the auricular second sound was noted in 15 per cent. It is evident that slight degrees of cardiac enlargement may be difficult to detect clinically. It is also probable that the long period of rest and the severe degree of hyperpiesis required to produce changes in the size of the heart sufficient to be detected were not present in many of our cases.

Peripheral sclerosis.—Sclerosis of the radial and brachial arteries was of sufficient degree to be noted in 15.4 per cent of our patients. Sclerosis of these vessels is not always found accompanying increase in arterial pressure.

Ocular fundi.—There were abnormalities of the ocular fundi in 57 per cent of our cases. In 20 per cent there were retinitis and

associated retinal sclerosis. In 31 per cent there was retinal sclerosis unassociated with retinitis. In 6 per cent the patients had retinitis only, and without changes in the retinal vessels. In 43 per cent, examination of the ocular fundi gave negative results. It is evident, therefore, that the disease involves the entire vascular system.

Table 2

ESTIMATION OF HEMOGLOBIN

Cases	Hemoglobin, per cent (Dare)
2	26-30
3	31-35
9	36-40
5	41-45
12	46-50
10	51-55
12	56-60
13	61-65
27	66-70
43	71-75
19	76-80
7	81-85
3	86-90
1	91-95

93 cases (56 per cent) with value for hemoglobin 70 per cent or less.
73 cases (44 per cent) with value for hemoglobin more than 70 per cent.

Hemoglobin and erythrocytes.—Brown and Roth have pointed out that there is a definite relationship between the degree of renal insufficiency and the degree of anemia. In their studies, the anemia of chronic nephritis had definite prognostic value approximating that of retention of creatinine. In our group of patients with polycystic kidney the value for hemoglobin of 93 (56 per cent)

was 70 per cent (Dare) or less (Table 2). Erythrocyte counts were less than 4,000,000 in sixty-two cases (42 per cent) (Table 3).

Table 3

ERYTHROCYTE COUNTS

Cases	Erythrocytes in each cubic millimeter of blood
1	1,750,000—2,000,000
1	2,000,000—2,250,000
5	2,250,000—2,500,000
5	2,500,000—2,750,000
9	2,750,000—3,000,000
5	3,000,000—3,250,000
17	3,250,000—3,500,000
8	3,500,000—3,750,000
11	3,750,000—4,000,000
16	4,000,000—4,250,000
25	4,250,000—4,500,000
21	4,500,000—4,750,000
12	4,750,000—5,000,000
2	5,000,000—5,250,000
2	5,250,000—5,500,000
6	5,500,000—5,750,000
1	5,750,000—6,000,000

62 cases (42.2 per cent) with erythrocytes of less than 4,000,000.
85 cases (57.8 per cent) with erythrocytes of more than 4,000,000.

The urine.—The specific gravity of the urine was less than 1.010 in 40.4 per cent of our cases. The value of low, fixed specific gravity from a prognostic standpoint is considerable. Albumin was present in 180 cases. This is of value in examinations for life insurance. Urinary casts were observed in 10.8 per cent of cases. There were erythrocytes in the urine in 44 per cent, and none in

56 per cent. Microscopic evidence of hematuria was noted in 34 per cent. Pus cells were found in 180 cases (94 per cent), in routine examination of the urine. Catheterized urine from either kidney often contains a variable number of pus cells. This is apparently the result of inadequate intrapelvic drainage, caused by cysts compressing the pelvis. Ureteral catheterization occasionally will cause acute exacerbation of the infection, and should be avoided when possible. Materials injected in the course of retro-

Table 4

RETURN FROM BOTH KIDNEYS OF INTRAVENOUSLY INJECTED PHENOLSULPHONPHTHALEIN

Cases	Per cent
27	Trace or less
18	Trace to 10
23	11 to 20
21	21 to 30
26	31 to 40
31	41 to 50
16	51 to 60
7	61 to 70
1	71 to 80

In 146 cases (86 per cent) combined return of phenolsulphonphthalein was 50 per cent or less. Output of dye in this range is considered to be reduced.

grade pyelography may be retained in the pelvis and may be the cause of serious renal infection. Organic compounds of iodine which recently have come into use are least irritating, but even with these it is advisable to leave the ureteral catheter in place for several hours in order to drain the renal pelvis, and to perform lavage of the pelvis with sterile solutions of boric acid. Although in some specimens obtained by renal catheterization only occasional pus cells were found, this does not exclude previous renal infection, and cultures were in some cases positive.

Renal function.—Regarding excretion of phenolsulphonphthalein

of 40 per cent or less as indicative of renal insufficiency, renal function was subnormal in 67 per cent of our cases. In twenty-six cases, return of phenolsulphonphthalein was 31 to 40 per cent; in twenty-one, 21 to 31 per cent; in twenty-three, 11 to 20 per cent; in eighteen, 1 to 10 per cent and in twenty-seven, only a trace of the dye, or none of it, was returned (Table 4). In most cases there was delayed excretion of phenolsulphonphthalein, as shown either by a retarded appearance time, or preponderance of excretion of dye in the last hour. Normal excretion of phenolsulphonphthalein should not be regarded as excluding polycystic disease, however. In many cases, although the specific gravity of the urine was found to be within normal limits (1.014 to 1.020), yet excretion of phenolsulphonphthalein was greatly reduced. Of interest is the lack of parallelism between the excretory and the retention tests for renal function in the earlier stages of renal insufficiency. Excretion of phenolsulphonphthalein is often markedly reduced, whereas the value for blood urea is normal or only slightly elevated.

Blood urea.—The value for blood urea was estimated in 117 cases of this group. In 67 per cent, seventy-eight cases, a value of 40 mg. in each 100 c.c., or more, was noted; in twelve cases, it was more than 200 mg. In only 33 per cent was the value for blood urea normal. It is remarkable to what extent tolerance to renal insufficiency may be developed with a concentration of blood urea of more than 200 mg. in each 100 c.c. A number of patients have been observed whose value for blood urea was 150 and 200, and who have been able to carry on with a fair degree of health over a period of several years. This is also true when the value for blood creatinine is between 5 and 10.

TREATMENT

The treatment of this condition may be either medical or surgical. In the great majority of cases medical treatment alone will be sufficient and should be directed largely toward relief of renal insufficiency and hypertension. General directions as to the method of life of the patient; dietary precautions consisting largely of restriction of intake of protein and prescription of simple foods, and supervision of the amount of exercise, hours of rest, and causes of worry and stress are the most important factors.

Urinary symptoms, as a result of secondary infection, are best

controlled by general antiseptic measures rather than by local treatment. It has been said that this condition is never surgical. However, experience has shown that surgical treatment is often of the greatest value to the patient. Although accidental removal of an uncomplicated polycystic kidney might well be disastrous if the other kidney were insufficient, nevertheless, complications may exist which justify nephrectomy. If there is diffuse secondary infection confined to one kidney, or if there are multiple stones scattered in the substance of the kidney, nephrectomy is the only method of relief, providing the function of the other kidney has been previously found to be sufficient to sustain life. Hematuria is usually limited and unimportant. It may, however, be persistent and a serious complication. Very often, on exploration, it will seem to have its origin in one or more cysts which are filled with blood. Puncturing and evacuation of the content of these cysts may be sufficient to stop further bleeding. Occasionally it may be necessary to remove the kidney. It sometimes happens that one or two cysts may become unusually large, and as a result may cause pressure on other organs, or on the abdominal wall, with pain. In some cases this may be overcome by destroying the walls of the cyst and by evacuation. Rovsing first suggested puncturing most of the visible cysts in order to overcome the pressure caused by the cysts on the remaining healthy parenchyma. Although the renal function has been improved, or at least conserved, by this operation in some cases, the experience of most surgeons has not been favorable. In several of our cases puncturing the cysts was followed by secondary infection of the remaining parenchyma of the kidney, necessitating nephrectomy.

Knowing the condition present, much can be accomplished by means of general treatment and advice to the patient, who should be informed as to the prognosis. Because of the hereditary nature of the condition it would seem advisable, as has been said, for the patient not to have progeny.

SUMMARY AND CONCLUSIONS

The average age of the patients at the onset of symptoms was thirty-eight and eight-tenths years. The average duration of life of the patients reported dead was fifty years. There was definite evidence of a hereditary trend. A systolic blood pressure of 145

mm. of mercury, or more, was found in 61 per cent of the cases; the diastolic blood pressure was more than 90 mm. in 55 per cent, and more than 95 mm. in 47 per cent. Peripheral sclerosis was observed in 15.4 per cent. Retinal sclerosis, with other ocular changes, was noted in 51 per cent. Laboratory evidence of renal insufficiency was present in more than 60 per cent. Surgical complications occurred in our series more frequently than usually is recorded, in approximately 20 per cent of our cases. There is usually lack of parallelism between the retention and excretory tests for renal function; evidence of reduced renal function is greater in the latter.

The importance of vascular changes in cases of polycystic kidney has been underestimated in the past. Arteriosclerotic processes may be falsely attributed to developmental disturbances in the tubules and glomeruli. Although a developmental defect probably is primary in the etiology of congenital polycystic kidney, many of the clinical and pathologic manifestations have their origin in an altered condition of the vascular system.

Renal polycystic disease is easily overlooked, and usually is overlooked in the course of general clinical examination, since there are often no symptoms present which would indicate renal involvement. The renal origin of the patient's symptoms is often recognized only in the course of routine study of renal function. The condition is often confused with nephritis unless careful abdominal palpation is made. Failure to discover that renal enlargement is bilateral may lead to the erroneous diagnosis of renal neoplasm. Bilateral urographic studies may be necessary to determine involvement of both kidneys when abdominal palpation reveals unilateral enlargement. The most common symptom is a dull pain, usually referred to either renal region. Urinary symptoms of moderate frequency, or occasional hematuria, are also often observed. The first clinical symptoms are frequently those of renal insufficiency, although a remarkable degree of tolerance is often noted in the presence of advanced renal destruction. Laboratory evidence of marked reduction in renal function, with comparatively few subjective symptoms, in the case of an adult who is in the third or fourth decade of life, should call attention to the probability of polycystic renal disease. The prognosis will vary largely with the degree of renal dysfunction. If renal function remains normal, the prognosis is good.

Even moderate reduction of renal function may remain stationary for as many as ten or fifteen years. When the reduction is advanced, the prognosis becomes grave, although several years may elapse before death. Expectancy of life will average almost fifty years, although patients are frequently observed who are more than sixty years of age. The hereditary nature of the disease should discourage the having of progeny, and sterilization should be advocated.

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FIBROMYXOSARCOMA OF THE SPERMATIC CORD

REPORT OF A CASE AND REVIEW OF THE LITERATURE OF CORD TUMORS

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We have encountered recently, in our service at the Royal Victoria Hospital, a very unusual case of a tumor of the spermatic cord. This has prompted us to report the case in question and to review carefully the literature and the pathology of tumors of the cord. We were rather surprised to find very little on the subject in any of our textbooks on urology and pathology. In the current literature, however, we have found several very interesting and comprehensive studies. Before discussing the classification and pathology a few historical notes are in order.

The first authentic cases of tumor of the cord found in the literature date back to 1845 when Lésauvage reported two patients with myxomatous growths. In 1857 Curling wrote an article on fatty tumors of the cord and discussed a case with a recurring lipoma. In the following year Poisson reported a case of a fibroma. Verneuil in 1864 and Louvet in 1865, each presented a case of fibrosarcoma. Following these, isolated cases of fibrolipoma (Tizzoni and Parona), myxosarcoma (Walsham), and medullary sarcoma (Bryant) appeared in the literature. It was not until 1884 that Brossard in an excellent treatise classified the tumors and reported on nineteen cases. In 1887 Alombert-Goget elaborated on Brossard's collection. He was able to gather twenty-five cases. Of these seven were lipomata; four carcinomata; three fibromata; one myxoma; nine sarcomata, and one unclassified.

A very complete résumé of the subject was made by Patel and Chalier in 1909. They were able to account for eighty-nine cases; thirty-seven lipomata; twenty-two sarcomata; thirteen mixed tumors; twelve fibromata; four myxomata, and one carcinoma.

Other short essays on the subject followed, but in 1924 an excellent paper was published by Hinman and Gibson, and for the first time a systematic classification of this group of tumors was submitted. They also reported a personal case of a pure fibroma.

In the same year Kelley described a case of fibroliposarcoma, and Günther a case of sarcoma.

In 1927, Rubaschow published a very elaborate and accurate treatise. He reviewed all the literature, offered a classification, and was able to collect one hundred and eighty-three cases. Since

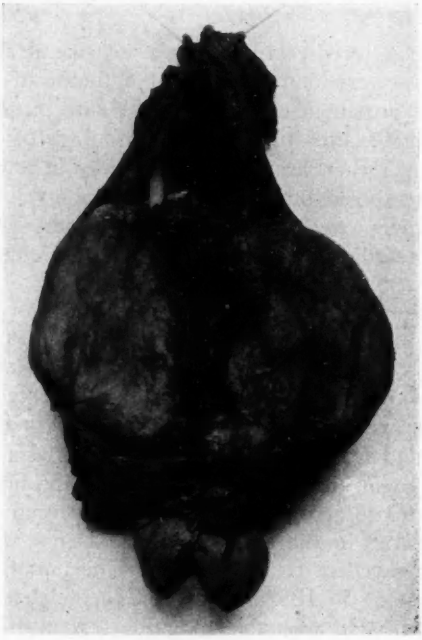

Fig. 1. Photograph of the gross specimen in question. Note the growth incised and below it a normal looking testis which has also been split.

then we have found fourteen more cases in the literature. We are also reporting a patient with a fibromyxosarcoma, making a grand total of one hundred and ninety-eight. Of the latter fourteen cases collected the following are the pathologic reports: lymphangioma (Rosenfeld); lipoma (Werwath); fibroma (Calissano); myoma (Leighton); fibrosarcoma (Chivalla); lipofibromyxoma (Maz-

zini); sarcoma (Karo); cavernoma (Arlotta and Dolfini); fibroplasmocytoma (Oelecker); angiomyxoma (Kerschner); connective tissue cyst (Esan, two; Prati, one); tumor of Wolffian body (Picard and Estan).

From the above historical data, it is obvious that tumors of the spermatic cord have been of extreme interest to the clinician as well as the pathologist, and have occupied a prominent position in the literature.

Classification.—There are two well established classifications of tumors of the spermatic cord: one presented by Hinman and Gibson and the other by Rubaschow.

The classification by Hinman and Gibson is as follows:

A. *Benign:*
   1. Epithelial (none recorded)
   2. Mesoblastic:
      (a) Lipoma
      (b) Fibroma
      (c) Myxoma
      (d) Leiomyoma
      (e) Vascular tumors.
   3. Heterologous tumors:
      (a) Cystic dermoid.

B. *Malignant:*
   1. Epithelial (none recorded)
   2. Mesoblastic:
      (a) Sarcoma (myxosarcoma, chondrosarcoma, fibrosarcoma, etc.)
   3. Heterologous tumors:
      (a) Teratoma (including seminoma of Chevassu).

Rubaschow also divides the tumors into two great classes, namely (1) Embryonal growths, and (2) Growths arising from local tissues. Under the embryonal tumors he includes the teratoma, the dermoid, and the heterologous tumors such as the myxosarcoma, the fibromyxosarcoma, the myxoliposarcoma, and so on. The second group is made up of the simple mesoblastic tumors, such as the lipoma, fibroma, myxoma, myoma and sarcoma, et cetera.

From these two classifications it is obvious that Hinman and

Gibson consider the myxosarcoma, fibromyxosarcoma, myxochondrosarcoma group as true simple homologous growths, while Rubaschow places them with the embryonal tumors. Patel and Chalier have gone even a step further and have put them in the group of mixed tumors and teratomata. We are inclined to agree with these latter authors. It seems reasonable to suppose that any one of

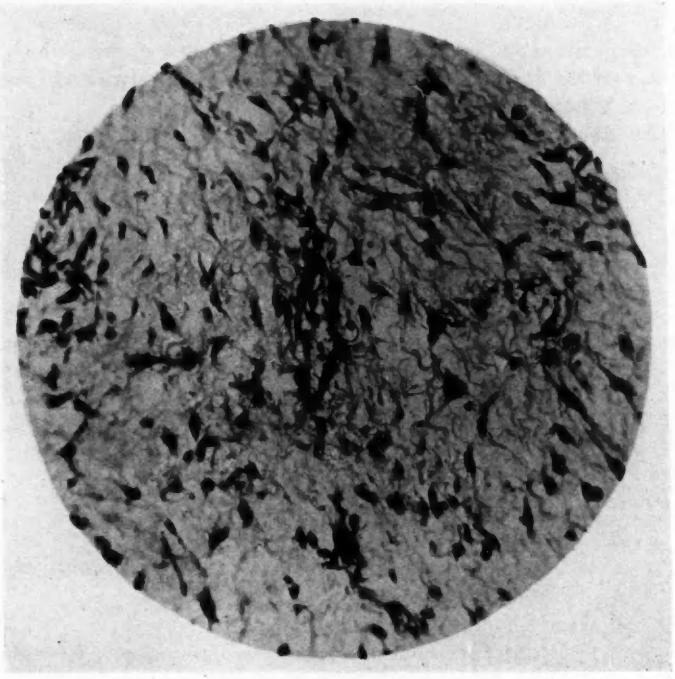

Fig. 2. Microphotograph showing wavy myxomatous tissue.

these growths may result from a one-sided development of a teratoma in which the mesodermal element has the upper hand. The same picture is present in cases of embryonal tumors of the testis, but here the ectodermal element has the prominent rôle. Hinman and Gibson apparently are opposed to this theory, and quote Schultz

and Eisendrath, who state that teratomata rarely exhibit sarcomatous changes.

The case that we are reporting (fibromyxosarcoma) is in this group, and we are of the opinion that it probably belongs to the class of embryonal teratomata in which the mesodermal tissue has developed at the expense of the other two elements, namely ectoderm and entoderm.

INCIDENCE

Tumors of the cord are certainly rare conditions. Rubaschow was able to collect 183 authentic cases only, over a period of eighty years. We have found fourteen other cases, which, together with our one, make a sum total of 198 tumors. These growths are divided as follows:

Lipomata	58
Embryonal tumors including the dermoid teratoma, myxosarcoma, fibromyxosarcoma, fibromyosarcoma, etc.	46
Tumors of the Wolffian body	19
Fibromata	25
Myxoma	1
Sarcomata	25
Connective tissue cysts	11
Lymphangiomata	5
Cavernoma	1
Myoma	1
Unclassified	6
Total	198

Location.—The majority of the tumors on record appear to have their origin in the left side. This fact is particularly striking in the case of the lipomata. There does not seem to be any rational explanation for this one-sided preponderance. Some authors believe that the left-sided varicoceles predispose to the condition.

Bilateral growths of the cord are extremely rare. There are only three authentic cases on record (Broca, Rossard, Werwath).

Tumors of the cord may extend upwards in the inguinal canal or may be found in the scrotum very closely associated with the epididymis and testis. Lipomata are mostly found in the canal and seem to arise from the fat lobules in the tunica vaginalis communis of the cord.

Fibromata are situated usually in the scrotum. Their origin lies in the connective tissue at the junction of the epididymis and cord.

The sarcomata are also usually within the scrotum, and very

often resemble a tumor of the testis. Occasionally, however, the inguinal canal is the seat of the growth.

Embryonal tumors are almost always situated where embryonal rests are commonly found, and that is, near and about the epididymis.

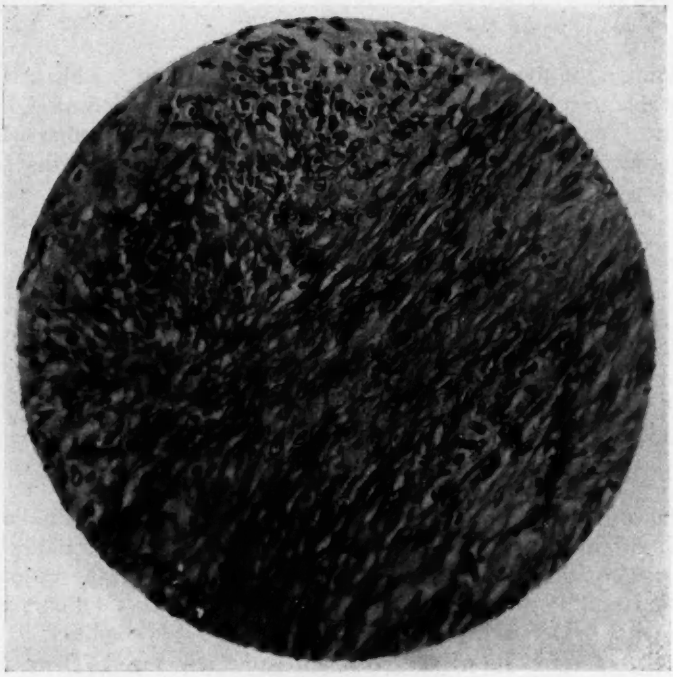

Fig. 3. Microphotograph showing an area composed of fibrils which show malignant proliferation.

Age Period.—Tumors of the cord may be present at any age. The majority of them occur between the ages of forty and fifty years. Debernardi describes a case of an embryonal tumor in a child ten and a half months of age. Hinman and Gibson mention three cases of mesoblastic growths occurring between seventy and eighty years of age.

Etiologic Factors.—Although several of the cases on record have had a history of trauma yet this factor is not considered as very important. Some authors (Opokin) consider a chronic inflammation of the cord as a predisposing cause. Regarding the embryonal tumors, they are of course due to cell rests that are often present near and about the junction of the epididymis and cord.

Symptomatology.—Very often the patient has no subjective symptoms at all. If the tumor is large there is a feeling of weight, and a dragging pain in the scrotum and groin. Occasionally shooting pains up and down the inguinal canal are complained of.

Loss of weight and strength are late symptoms, and are present only when metastases occur.

Diagnosis.—If the tumor is in the inguinal region, it must be differentiated from the following conditions: (1) Hernia; (2) cyst of the cord; (3) hydrocele of the cord.

If the growth is in the scrotum it may be mistaken for: (1) hydrocele; (2) hernia; (3) tumor of the testis; (4) hematocele; (5) spermatocele; (6) syphilis; (7) tuberculosis.

Very often diagnosis is difficult. This may be particularly striking when a blood Wassermann is positive. The case we are reporting belongs to this very class.

Prognosis.—The benign mesoblastic growths (lipoma, fibroma, etc.) grow slowly, and it may take ten to fifteen years before they reach large dimensions. They are not malignant, but it must be kept in mind that any of these tumors may take on sarcomatous characteristics at any time.

The dermoids are usually quite benign and small. Occasionally, however, they grow rapidly and reach tremendous sizes.

The sarcomata and the other embryonal tumors are all malignant, or potentially malignant. They grow rapidly and metastasize early.

Treatment.—Simple removal of the benign growths is sufficient. They are usually encapsulated and are shelled out easily. Regarding the sarcomata and the embryonal growths, more radical treatment is necessary. The tumor, the testis, the epididymis and as much of the cord as possible should be removed. This treatment may be followed by several courses of deep X-ray therapy.

SUMMARY

1. The literature on tumors of the spermatic cord is reviewed.
2. Two classifications are given.
3. The pathology is discussed.
4. Fifteen authentic reports are added to Rubaschow's list to make a total of 198 cases.

CASE REPORT

The following is the record of the patient with such a growth:

F. G., single, aged sixty-seven years, was admitted to the Urological Service of the Royal Victoria Hospital on November 30, 1931, complaining of: (1) Mass in the left side of the scrotum; and (2) pain in the left groin.

The history dates back to August, 1931, when the patient first noted a small mass in the upper portion of the left side of the scrotum. It was not tender nor painful at that time. The mass gradually increased in size, and in the middle of October, 1931, was the size of a plum. The patient came to the genito-urinary outpatient department on November 10, and on routine examination the blood Wassermann was reported as three plus positive. He was given anti-luetic treatment, but the mass increased in size. The Wassermann, however, became negative. A tumor in the scrotum was now seriously considered, and the patient was admitted to the ward.

Personal and family history were irrelevant. The patient denied venereal infection, and any injuries.

Physical examination showed the eyes, ears and nose to be normal. The teeth were dirty, with some pyorrhea alveolaris. The tonsils were both mildly hypertrophied. The tongue was clean and moist. The lymphatic system was negative. A few coarse crepitations were heard at both bases of the lungs posteriorly. There were no other abnormal findings. The cardio-vascular system was normal. Blood pressure was systolic 130; diastolic 80. The findings in the gastro-intestinal system, the nervous system, and the skin and integumentary system were negative.

The genito-urinary system was negative except for the local condition in the scrotum. On the right side the testis was small but normal in consistency. The epididymis, vas and vessels were normal. In the left side of the scrotum was a large hard mass the size of an orange. It was not adherent to the skin of the scrotum, and was not tender. It was not fluctuant and did not transmit light. Below the mass was a small but apparently normal testis, with normal testicular sensation. The lower pole of the epididymis was easily palpated, but the upper pole seemed to be lost in the mass. The cord could be felt above the mass but not below it. It was definitely enlarged. The vas could be palpated, and seemed definitely thickened but not tender.

Laboratory findings were as follows: Urine—clear amber, acid in reaction, specific gravity 1.014, albumin trace, sugar none; microscopic—white blood cells scattered, oxalate crystals, epithelial cells; blood urea—19.9 mgms. per cent; blood creatinine 1.18 mgms. per cent; white blood cell count, 8,300. Blood Wassermann was negative though positive in outdoor examination three weeks previously.

Diagnosis was tumor in the left side of the scrotum. Left orchidectomy was performed, and the mass in the scrotum was removed. The patient was discharged on December 14, 1931, as cured. The pathologic report was as follows: Gross specimen consisted of left scrotal contents, including testis and epididymis which were normal appearing and free. Superior to these and more or less surrounding the cord was a large tumor mass the size of a tangerine. It was incised, revealing pinkish white, firm, somewhat shiny walls. Upon microscopic examination sections showed a neoplastic growth consisting of a malignant proliferation of immature mesodermal elements which in some areas formed fibrils giving a positive collagen reaction, while in other areas a fine wavy myxomatous tissue was found. A large part of the growth showed necrosis. There was no evidence of any ectodermal derivations. Extraordinary was the throwing down of a pink-staining intercellular matrix similar to that encountered in bone sarcomata. The growth was well demarcated by a mature appearing fibrous capsule. There was a certain amount of purulent inflammatory reaction, particularly in the surrounding tissue. Anatomic summary was fibromyxosarcoma.

Serial sections of the testis and epididymis revealed normal tissue, with no evidence of growth.

It is interesting to note that there are only two other cases of fibromyxosarcoma in the literature. One was reported by Porges in 1897, and the other by Giordano in 1912.

COMMENT

This case is a most interesting one. It emphasizes the fact that one should not be misled by a positive Wassermann reaction, and that both syphilis and a tumor may co-exist at the same time. The therapeutic test should always be performed when there is any doubt. If the mass is syphilitic, it will decrease in size with antiluetic therapy. If it is a tumor the size will not be influenced by the treatment.

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DISCUSSION

Dr. Edward L. Keyes (New York City): Dr. Braasch's tabulation of the symptoms and the prognosis of polycystic kidney is most timely. Medical men often insist that a patient has not polycystic kidneys because the blood pressure is not high. Dr. Braasch shows that the blood pressure is above normal in the majority of cases. Yet I think one should especially remember that this is not inevitable.

I can remember in particular one woman whose abdomen was filled with polycystic kidneys and who had a very low function (though her blood chemistry was approximately normal) and upon whom operation was proposed for the purpose of relieving the pressure symptoms from this tumor. I was unable to persuade the surgeon that the patient would surely die after this kidney was operated upon, because the blood chemistry was so good and the blood pressure was so low. The event proved their error.

Dr. Braasch did not, I should say, insist upon a feature of these cases which has rather impressed me in distinguishing them from malignant renal tumors. These patients, of course, die relatively young. He mentioned an average age of death of about fifty, I think. I should like to know the extreme age of death. Renal tumors occur in the fifties, and these polycystic kidneys occur, I believe, habitually in patients ten or more years younger.

I should like to mention a case which I could not officially report because, unfortunately, the kidney was lost. The patient had perirenal hematoma so large that it enveloped the kidney. The kidney was removed. I had not done a bilateral pyelogram. The kidney was then sectioned, and grossly the appearance was of polycystic kidney of the middle third of the kidney. The upper and lower poles were grossly normal. I do not know that a partial polycystic kidney has ever been reported. I subsequently made a pyelogram on the opposite side, and the pyelogram was normal. The patient was alive and apparently well two years after the operation.

Dr. Frank S. Patch (Montreal): I would like to show a few slides:

(Slide) The first is concerned with papillary tumors of the pel-

vis, which was the subject of my maiden effort before the Society. This patient had hematuria. This is the reproduction of the pyelogram, showing the dilated pelvis with the papillomata in the pelvis. The tumors in this case we thought arose from a papillary cystadenoma of the renal cortex by transplanattion of the cells into the pelvis.

The tumor, when subjected to microscopic examination, showed a potential malignancy, in that the cells were beginning to invade the submucosa of the pelvis. At the time, therefore, a nephroureterectomy was done. Subsequently the patient suffered from recurring papillomata of the bladder, which were more or less successfully fulgurated. The patient attended very irregularly. After a long absence, I saw him about a year ago, with a return of the hematuria. Examination revealed a pedunculated tumor in the bladder, about the size of a lacrosse ball. This tumor was excised. Curiously enough, a careful serial section of the tumor showed no signs of the malignancy which was found in the original tumors in the kidney pelvis.

(Slide) This is a picture of a section of the kidney, showing a small papillary cystadenoma of the cortex with the invasion of the pelvis. We assumed that the cyst entered the pelvis by transplantation, in a slightly different type of growth.

(Slide) This is the pyelogram of another case of papilloma of the pelvis, in which the diagnosis was difficult. The aged patient had hematuria, and this was the only symptom. We assumed from the pyelogram that we were dealing with a tumor of the lower pole. The section of the removed kidney, however, showed that the growth was a papillary tumor of the pelvis. The case is interesting because of difficulty in the interpretation of the pyelogram.

(Slide) One hesitates to show pyelograms of polycystic kidneys after Dr. Braasch's extensive series. This is a case in which the internist had made a diagnosis of renal tumor because the patient had carcinoma of the orbit and one palpable kidney. His diagnosis was metastasis from renal tumor. The tumors were bilateral and the patient had hypertension. The patient was in the early forties. Here is the bilateral pyelogram. What I would emphasize is the bilateral bizarre character of the pyelograms.

(Slide) The patient died a few months later of carcinoma of the orbit. This slide shows the sectioned kidneys.

(Slide) This is the pyelogram of a woman in the late thirties, with a moderate amount of hypertension, who very narrowly escaped having one kidney taken out by a general surgeon for a renal tumor, without consulting a urologist. This slide shows a pyelogram of one of the kidneys, which exhibits the characteristic bizarre appearance.

The next (slide) shows the other kidney. The long crescentic streak we assume is due to pressure by a large cyst.

(Slide) This is the pyelogram of a patient interesting on account of her symptoms. It emphasizes a point Dr. Braasch did not bring out. This patient was subject to recurrent intermittent attacks of hydronephrotic colics. The kidney was palpable on the right side. Clinically, it appeared to be a ptosed kidney, with recurring attacks of hydronephrosis. She had some hypertension. The examination showed a polycystic kidney with one large cyst in the middle. Apparently by the weight of the kidney itself, or possibly this heavy cyst, the kidney had sagged downwards.

This cyst was incised, the contents liberated, and a nephropexy done. I saw the patient ten years afterwards, and she has been perfectly free from her attacks of pain, although she still shows signs of renal failure associated with hypertension.

Dr. George R. Livermore (Memphis): I would like to bear Dr. Scholl out in his contention that stones may have some effect upon the etiology of carcinoma of the kidney.

(Slide) This was a case of hypernephroma in a man about thirty-six years of age, who was cystoscoped and X-rayed about five years before I saw him, and a stone found in the parenchyma of the kidney. The patient would not submit to operation. At the time I saw him he was complaining of pain in the loin, frequency, burning and hematuria. Upon examination, we found the stone about twice as large as when seen five years before, and a bulge upon the convex border of the kidney. He was having attacks of chills and fever. Colon bacilli, pus and blood cells were found in the urine. The patient was operated upon for removal of the stone, and the bulging area seen in the X-ray proved to be a hypernephroma of the kidney. If the patient had had the stone removed five years before, it is possible that he would not have developed a hypernephroma.

(Slide) Here is a case we reported before the Association some

years ago, of papillary adenoma carcinoma of the pelvis. He did well, until, as I reported last year, he developed metastasis to the bladder. In this case the kidney and ureter were removed. The implantation in the bladder did not show any malignancy, yet under fulguration it did not disappear, but with combined fulguration and deep X-ray therapy it vanished after a few treatments.

(Slide) This is a picture of the tumor of the pelvis.

(Slide) Another case we had was a man about fifty-five or fifty-six years of age, who had papillary adenoma carcinoma of the pelvis. It recurred in the bladder about a year after this operation was done.

(Slide) This is an intravenous pyelogram of the same case.

In regard to the polycystic kidney, removal of a polycystic kidney may be a dangerous procedure, as we know it is usually bilateral. Some five years ago we had a patient who had polycystic kidneys and had had profuse and constant hematuria for some weeks. He was very anemic, his red cell count being about 2,000,000, and hemoglobin about 30 per cent. We transfused him twice, and still the hemorrhage continued. So we put it up to him and his family, and with their consent operated on him in order to try to check the bleeding.

When the kidney was exposed it seemed practically destroyed, and was bleeding freely. The P.S.P. of the other kidney was very poor, but we took a chance and removed the kidney. It is wonderful what nature can do. He had uremic symptoms for about one week, but the other kidney responded to the call upon it and he made a good recovery. He is still alive, attending to his business, and is an insurance agent, enjoying moderately good health.

DR. V. J. O'CONOR (Chicago): I would like to add two personal cases of papillary carcinoma of the renal pelvis that are interesting.

One is in line with Dr. Scholl's contention of stone formation and tumor. This man, upon whom I operated in the spring of 1920, at the age of seventy, had a left intermittent pain for ten years and bleeding from the kidney for ten years. The X-ray examination had previously been done by competent urologists who made a diagnosis of solitary cyst of the kidney with stone. The man refused operation, until I saw him ten years later. It was impossible to pass the ureter as the stones were impacted in the upper portion.

At operation I removed a very large hydronephrotic sac. We took the ureter off just below the uretero-pelvic junction where the stones were impacted. Afterward, when we split the kidney, we found that the pelvis was entirely filled with papillary carcinoma. Dr. Le Count examined the sections. I advised complete ureterectomy, but his brother, a doctor, didn't wish to have it done. The man is now seventy-six years old, in perfect health, with no trouble and no recurrence in the urinary tract.

The second patient had a single hematuria in 1926. This man weighed 285 pounds and was a conductor on the North Western Railroad. His doctor insisted on a urological examination, which showed a pyelographic deformity of the left superior calyx. We removed the kidney, thinking he had hypernephroma. Examination showed papillary carcinoma of the superior calyx. He is perfectly well with no urinary symptoms since.

One patient was sixty-seven years old and the other seventy. Both had active papillary carcinoma of the renal pelvis. With both I recommended secondary ureterectomy. Both refused, and both are perfectly well.

DR. A. J. SCHOLL (Los Angeles): In answer to Dr. Livermore, it makes little difference what histologic term we put on the type. Of course, squamous cell tumors are more likely to rise following irritation, whether prolapse of the uterus, in the mouth, or in other organs.

The point I desire to make is, that we know a good many of these cases have a long history of stone formation. Before the onset of malignancy, it is a simple procedure to remove the stones; after malignancy has developed, the prognosis is very bad.

DR. WILLIAM F. BRAASCH (Rochester, Minnesota): Although Dr. Scholl's observations are of considerable clinical interest, nevertheless, the percentage of carcinoma resulting from renal stone is very small. In our series of over a thousand patients operated on for renal lithiasis we have observed only seven or eight in whom carcinoma may have developed as the result of stone. On the other hand, carcinoma occurs more frequently with chronic cholelithiasis. It is open to question whether the incidence of cancer following renal stone is great enough to warrant its use as an argument in favor of immediate surgical removal.

My observations concerning polycystic kidney were confined to the clinical and pathologic data and did not include its surgical treatment. Doctor Walters and I plan to issue a paper on that subject in the near future.

Dr. Keyes brought up the question of hypertension with polycystic kidney. It occurs in something like 60 per cent of patients observed. Although hypertension may be one of the earliest clinical data observed, it is usually not marked until after forty years of age. However, exceptions to this rule frequently occur. Normal blood pressure is seldom observed when the patient is over fifty years of age, although in recent years we have observed several cases. Several weeks ago a patient seventy years of age who had a normal blood pressure, died as the result of a cardiac lesion and autopsy showed the presence of advanced polycystic kidneys. All of which shows that no rule holds good in all cases.

The differential diagnosis between renal tumor and polycystic disease may be difficult. Abdominal palpation will frequently reveal only one kidney definitely enlarged and suggest the diagnosis of renal tumor. The diagnosis is best established by urography. Although the deformity with polycystic kidney may resemble that observed with renal tumor, it can usually be recognized by the existence of deformity in both kidneys. A pyelogram of a polycystic kidney which is difficult to differentiate from a normal pelvis has been observed, but this seldom occurs.

It is doubtful if true unilateral polycystic kidney ever occurs. A condition is occasionally found which may easily be confused with polycystic disease, namely multilocular cyst. With this condition one portion of the kidney may be involved by multiple discrete cysts which are usually circumscribed. In some cases one pole of the kidney is involved and the remaining renal tissue is normal and free from cysts.

Dr. A. J. Scholl (Los Angeles): I am not certain that Dr. Braasch understood my point. I am referring to squamous-cell tumors of the kidney. Malignancy usually develops in these cases after a long history of pain and stone formation. I do not mean that every stone should be removed at once to prevent malignancy; after stones have been present for twenty years, there is a possibility of secondary tumor formation which might be prevented by removal of the stones.

LIPOMATOSIS OR DESTRUCTIVE FAT REPLACEMENT OF THE RENAL CORTEX

REPORT OF ELEVEN CASES

HUGH H. YOUNG, M.D.

From the James Buchanan Brady Urological Institute, Johns Hopkins Hospital, Baltimore, Maryland

Invasion of the kidney by fat and extensive replacement of the cortex by lipomatous growth has been recognized as a rare concomitant of nephrolithiasis for many years. In four cases it has been found present when pyelonephritis was discovered. No case in which neither stone nor infection was present had apparently ever been seen until the following patient came to our clinic in September, 1931.

A man, sixty-six years old, was admitted September 3, 1931. For over two years he had had attacks of dull aching pain localized to the lower left side of the abdomen just below and to the inner side of anterior-superior spine. He never experienced any attacks of kidney colic or radiating pains and there was no history of calculus. About fifteen months ago he sought relief at a hospital, where cystoscopy and ureteral catheterization were carried out. A diagnosis of kink of the left ureter was made, but no special treatment given. Another urologist dilated the ureter four times at monthly intervals without benefit. The last dilatation was four months ago. The condition had remained about the same. Pain started on arising in the morning, lasted for several hours and sometimes returned later. It was present every day, began at a spot, which he pointed to with his finger, and was about 5 inches from the umbilicus and 1.5 inches below it, just above the left anterior-superior spine, and 3 inches away from it. A typical attack started before his bath, reached a maximum in 2 minutes, continued during breakfast, and while at work sitting at his office desk. After about three hours the symptoms gradually passed away. Occasionally the pain was much more severe and so intense that he had to lie on his back on the floor until the pain passed. He has never had an attack while lying in bed. There were no urinary symptoms, and never any hematuria or passage of calculus.

Examination showed a healthy looking man. The chest was negative. In the standing posture, while grasping the right side between thumb and finger, a normal kidney, moving with respiration, was felt. The left kidney appeared larger and lower than the right; outline indefinite. Palpation at the point designated by the patient as where the pain

began elicited only slight tenderness. No mass could be demonstrated at that point. Genitalia: the prostate and seminal vesicles were negative. The urine was clear.

Impression: In view of the patient's statement of the previous find-

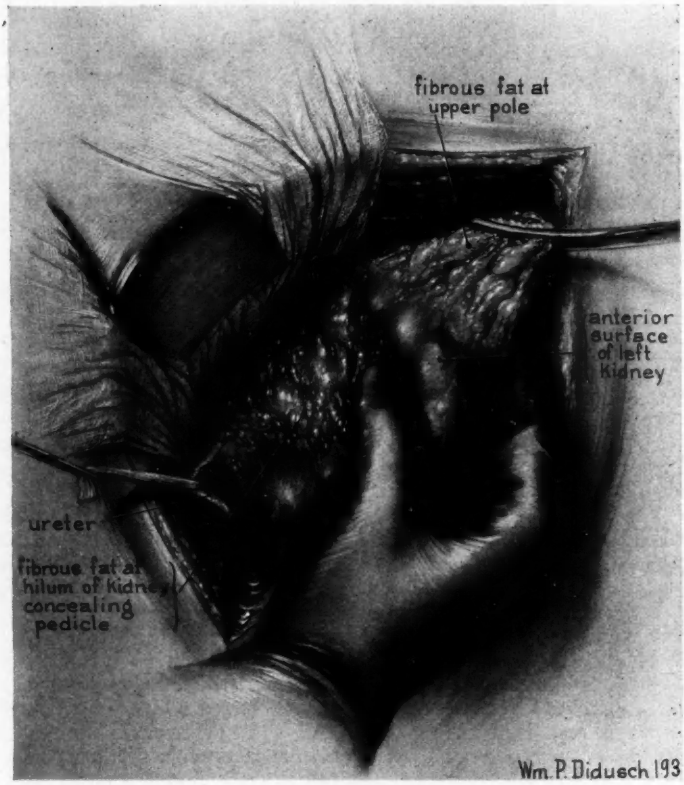
fibrous fat at upper pole
anterior surface of left kidney
ureter
fibrous fat at hilum of kidney concealing pedicle
Wm. P. Didusch 193

Fig. 1. Drawing made at operation showing the anterior surface of the left kidney exposed. The ureter has been freed. Note the fibrous fat adherent to the upper end at the hilum concealing the kidney pedicle.

ing of a ureteral kink, it seemed advisable to carry out pyelography in prone and upright positions and other urinary studies. Cystoscopy: bladder and prostate normal. The ureters were catheterized. Urine clear; cultures taken; subsequently reported sterile. Dif-

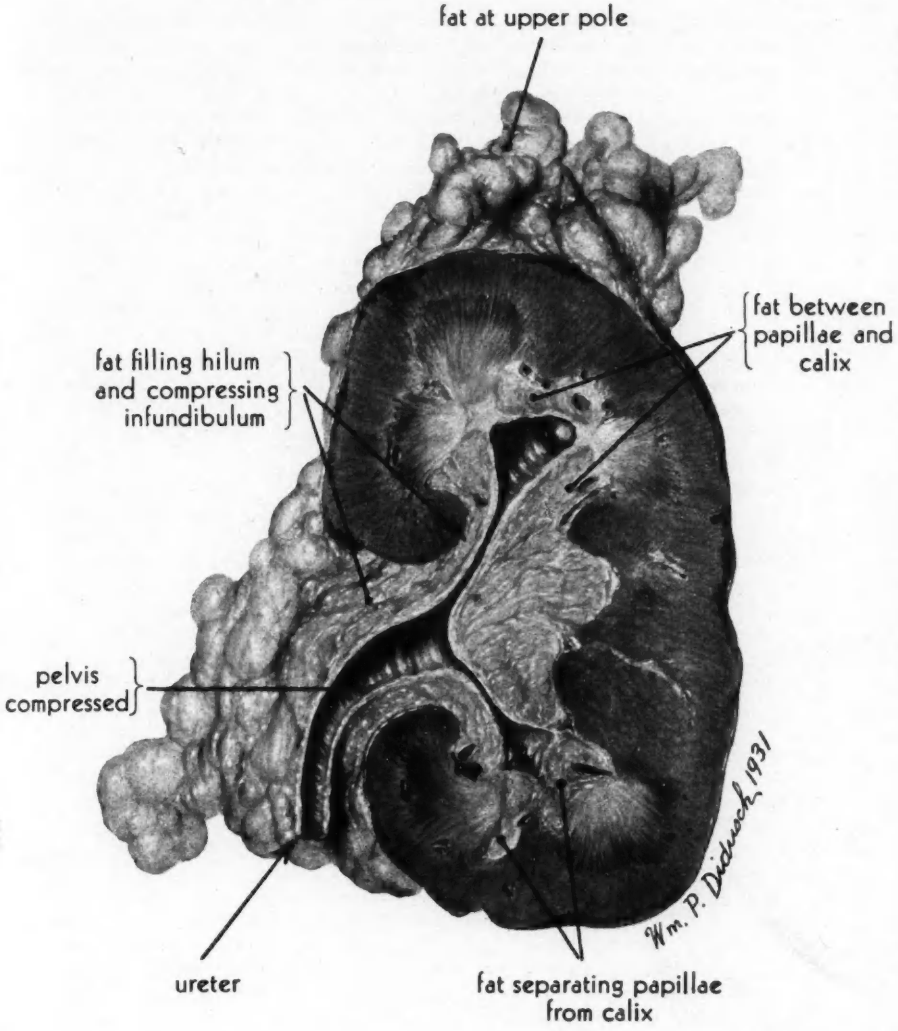

Fig. 2. Longitudinal section in a case of lipomatosis of the kidney, in which there was no calculus or renal infection. The fat around the pelvis which invaded the kidney and surrounding the infundibula and calices is shown.

ferential phthalein: right, appeared in 3 minutes, 12.5 per cent in 15 minutes; left, appeared in 4 minutes, 5.5 per cent in 15 minutes. Bilateral pyeloureterograms, prone and upright position, showed the right kidney pelvis and ureter normal. In the upright position kidney dropped about 3 cm. The left kidney was a little larger than the right, the pelvis was irregular, and there was a marked filling defect in the central portion, in which the calices were absent. The upper and lower calices were negative. The infundibula were compressed. There was no dilatation of the pelvis. The ureter was negative. There was no evidence of stricture. In the vertical position the kidney dropped 3 cm. There was no kink in the ureter. The impression was of a filling defect, suggestive of tumor. Intravenous neoiopax gave a picture similar to retrograde pyelogram. In all films both sides of the urinary tract were clearly visible. The right kidney and ureter were normal. The left side showed a filling defect involving renal pelvis and calices of the lower pole. Calices of the upper pole were well filled. There was no hydronephrosis. The ureter and bladder were normal. Impression was of an intrarenal tumor, compressing the calices, infundibula and pelvis.

Operation was performed (Young) September 11, 1931, using avertin anesthesia, supplemented by ethylene. A left nephrectomy was done through an extraperitoneal, muscle-cutting oblique incision. When the peritoneal fascia was reached, an unusual amount of fatty tissue, which was much firmer than normal, could be palpated beneath it. When the fascia was opened, an area of lobulated fat 2 to 3 cm. thick was found around the kidney, and in places, particularly at the upper pole, it was very adherent. It was also very abundant and adherent at the hilus and around the pedicle. It was stripped off with some difficulty, but cleanly, except at the lower pole, where some of it remained adherent. The kidney was not enlarged. Its upper half seemed to be normal, except for adherent fat at the upper pole, as shown in Figure 1. The lower half was a little enlarged, somewhat irregular, with several areas in which the kidney tissue was firmer than normal. In the intervening areas it was soft. The renal capsule was intact everywhere except at the lower pole, where a small amount stripped off with the adherent fat. There was an excessive amount of indurated fat around the pedicle and hilus which suggested to me pictures that I had seen in lipomatosis with stone in the kidney, and I said that I believed we would find no real tumor, but a lipomatosis, and that it would be advisable to carry out nephrectomy. The ureter was ligated 5 cm. below the pelvis and pedicle, clamped triply, divided and ligated with chromic catgut. The muscles and fascia were approximated with continuous chromic catgut and the skin closed with interrupted fine silk with deep silver wire tension sutures.

Pathology: The specimen was a kidney with pieces of attached fat weighing 218 grams, and measuring $10 \times 6 \times 5$ cm. Attached

to the capsule were numerous fatty tags and at the upper pole a fairly large mass of fat. The fat was firmer than normal. There was a considerable excess of fat around the pedicle of a similar character and this extended along the renal vessels into the hilus. The kidney was normal in shape. The true capsule was very adherent, and could only be stripped up in small pieces. There were several areas where the capsule was drawn into the cortex by adhesions, thereby causing depressions with scarring. On bisecting the kidney the picture presented was graphically shown by Mr. Didusch's colored drawing (Fig. 2). The most striking thing was a considerable layer of fat which followed the pelvis and infundibula through the hilus into the kidney,

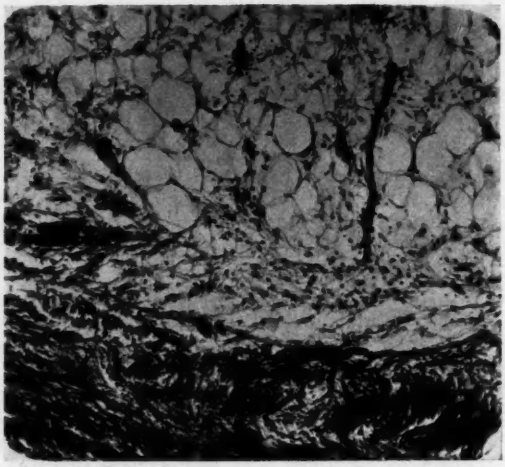

Fig. 3. Photomicrograph shows the invading fat with lymphocytic infiltration. Note the heavy fibrous septa separating lobules of fat.

continued around the calices, but did not infiltrate the pyramid with its collecting tubules.

Outside this fat was a narrow layer of renal cortex. The cortex appeared normal except for a few depressions previously described. The medullary rays appeared as in the normal kidney. The calices were sharp and cup shaped. The kidney pelvis was narrower than normal and the ureter was apparently normal. The layer of fat, which surrounded the pelvis, infundibula and calices, varied from 0.5 to 2.5 cms. in thickness. It had markedly compressed these waterways, but had not broken through the mucous membrane or produced ulcera-

tions. The fat was quite firm, but perfectly normal in appearance.

Microscopic examination of four sections showed evidence of perinephritis, fatty capsule slightly indurated and adherent to the capsule. Glomeruli were normal. Tubules were intact showing no compression or dilatation. The large arteries were deeply embedded in the fat. The mucous membrane was normal with no evidence of back pressure damage, infection or inflammation. In places the calices were compressed by the fatty tissue which was considerably infiltrated with round cells, and occasionally areas of fibrosis were seen (Fig. 3).

Between this invading fat and renal tissue the same fibrous mem-

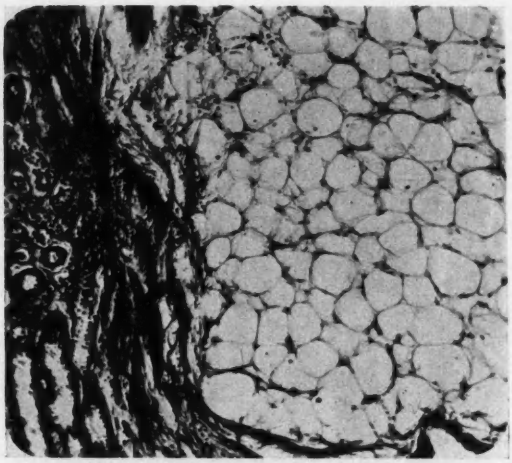

Fig. 4. Photomicrograph shows invading fat, separated from the renal tubules by fibrous membrane. The fat appears normal in this section.

brane (Fig. 4) can everywhere be seen. One section (Fig. 5) including pyramid and cup showed the minor calix to be embedded in fat. There was no invasion beyond the pyramid and cup. No stone was present, nor any suggestion of pyelitis or pyelonephritis.

The convalescence was uneventful. The wounds healed well and the patient was discharged in four weeks. There was no return of pain, and the general condition was excellent one year following operation.

COMMENT

We have in this case a patient suffering from pain in the lower left quadrant, a filling defect in the pyelogram, suggesting tumor.

Nephrectomy disclosed firm, adherent perirenal fat, which was particularly pronounced around the ureter and vessels of the pedicle, invading the hilus, and surrounding the pelvis, infundibulum and calices, and resulted in compression of the major calices. This caused a filling defect in the pyelogram, by the interposition of this wide layer of fat between the infundibulum, calices and cortex. It is difficult to understand why this phenomenon caused so much pain. Perhaps the invading fat may have altered the physiologic con-

Fig. 5. Photomicrograph shows a portion of a pyramid, a small portion of the minor calix, lined with transitional epithelium. Fat with a large lymph node is separated from the calix by fibrous tissue. Note that the fat does not invade the region of the pyramid.

tractions and obstructed the emptying of the calices. Nephralgia, which has been described by Rovsing as accompanying perinephritis, may have been present in this case. The distortion of renal capsule caused by an increase in fat around the pelvis and calices might account for the pain. Careful search of the literature by Lewis shows that this case is unique in not having been associated with stone nor inflammation within the pelvis or calices.

We wish herewith to report also ten cases in which either stone or intrarenal infection was present.

In this second group we have two cases of fat invasion of the kidney occurring with unilateral upper tract infection in the absence of stone. In one case it was present for fourteen years and the other for seven years. One patient had a pyelolithotomy performed for stone seven years before admission. The other had a perinephritic abscess incised and drained. In both cases pain was present, radiating from the left costal angle to the crest of the ilium. Both patients had pyuria and suffered from the usual symptoms of chronic cystitis. In one case there were frequent attacks of chills and fever. General examination was quite negative. The urine was purulent, and B. coli were present. Differential P. S. P. showed no dye coming from the affected kidney in either case. The diagnosis was non-tuberculous, completely destructive, pyonephrosis, and on this account nephrectomy was carried out. At operation the perirenal fat was abundant, firm and very adherent to the kidney, making nephrectomy difficult. The specimen removed was small, measuring 8 x 6 x 5 cm., and weighing 120 gm. There was an extensive perinephritis with fibrotic fat centering at the hilus of the renal pelvis, intrarenal and invading in a large fatty mass. On section this fat quite completely compressed the pelvis and calices, practically obliterating the lumen. The renal cortex was very thin, greatly scarred, contracted, and surrounded the large mass of fat which had apparently invaded the kidney from the region of the pedicle, compressing and almost obliterating the pre-existing hydronephrosis. Microscopic section showed extensive perinephritis, great scarring of the renal substance, hyalinization of the epithelium, compression and obliteration of the tubules and fibrosis of several glomeruli.

The invading fat showed a slight increase in fibrous tissue and diffuse round cell infiltration around the compressed calices. In no place did the fat infiltrate the renal substance, and there was again a well developed fibrous capsule between the fat and the cortex. The walls of calices and pelvis showed much destruction of epithelium and marked evidence of infection.

The second specimen measured 8 x 4 x 2 cm. and weighed only 55 grams. Intracapsular nephrectomy had been done and the surface showed great scarring; no extrarenal pelvis. The pelvis and major calices were practically obliterated by invasion of fat through the hilus, which extended to the thinned out cortex filling the pre-existing hydronephrotic cavity.

COMMENT

In these two cases of fat invasion in the absence of stone, there was marked evidence of infection. The invading fat had obliterated

the hydronephrotic calices. Pressure atrophy probably played a large rôle and resulted in the thinning of the renal cortex until it formed only a small capsule around the renal fatty mass.

In the third group we have eight cases of fat invasion of the kidney associated with nephrolithiasis and infection. Lumbar pain radiating to the groin, with pyuria, frequent hematuria and cystitis had been noted. The disease had existed from two to twenty-five years. Cultures showed B. coli 3, staphylococcus 3, mixed infection 1, sterile pyuria 1. Pyonephrosis was associated with neophrolithiasis in seven, large calculi were found in the renal pelvis in three and also in the calices in four. Filling defects were produced by the stone in all cases. In four practically no solution passed the obstructing pelvic calculus. In these eight cases the renal function was zero on the affected side. Nephrectomy was carried out in all. At operation an increase of perirenal fat with adhesions was always noted.

One case is of special interest. This patient had pyuria and hematuria without pain twenty years before admission. X-rays were taken at that time, and nephrolithiasis was suspected. An exploration was made, but on palpation of the exterior of the kidney no stones were detected. The kidney was therefore not disturbed and the wound was closed. Two weeks later an abdominal operation was performed, and many stones were removed from the gall bladder. Fourteen years later the patient came to this clinic; a stone was discovered in the right kidney by X-ray, but on account of attacks of angina pectoris, operation was not advised. Four years later he returned with pain in the lower right back, radiating along the crest of the ilium to the groin. Urine from the right side was purulent; from the left, clear. Differential P. S. P.: Right, mere trace; from the left, 20 per cent in 15 minutes. X-ray showed a large calculus in the right kidney. At operation a round lipoma 7 cm. in diameter was encountered. It was attached to the lower pole of the right kidney, which was also surrounded by much indurated fat. This lipoma was removed in order to facilitate exposure of the pelvis. Nephrectomy was then accomplished without much difficulty. There was a great increase in the fat which surrounded the pelvis and entered the hilus. The removed kidney mass measured 13 x 11 x 9 cm., the lipoma 9 x 6 x 5 cm., total weight 850 grams. The fat was lobulated with an increase of fibrous tissue. There were numerous perinephritic adhesions, and the capsule was very fibrous. The kidney was soft. Section through the kidney showed the specimen to be composed almost entirely of fatty tissue similar in appearance to the lipoma. The ureter could not be located, being apparently completely obliterated and destroyed.

The major calices were greatly compressed and a stag-horn calculus filled the lower and middle calices, about which was a slight hydronephrosis. The cortex was represented by a thin capsule surrounding the inflammatory mass.

Study of the other seven cases associated with neophrolithiasis showed varying degrees of replacement of hydronephrotic cavities by fat. The amount of fat invasion seemed to vary with the degree of hydronephrosis. Those cases in which the renal pelvis was blocked by stone, with the resultant hydronephrosis—and afterward fat replacement—varied with the degree of obstruction. In pelvic obstructions the fat replacement extended throughout the hydronephrotic process, obliterating the pelvis and main calices, leaving small hydronephrotic pockets in the region of the minor calices. In two cases in which the incomplete pelvic obstruction was associated with complete obstruction of one major calix by a stone, the fat replacement occurred in that portion of the hydronephrosis associated with the completely obstructed calix. In other portions of the kidney incomplete pelvic obstruction resulted in hydronephrosis without fat invasion. In one case a stone had blocked the lower major calix and the resultant hydronephrosis was completely replaced by fat, which had grown in from the renal pelvis around the pelvis along the major calix into the region of the hydronephrosis. As in the previous cases the fat was always separated from the renal substance by firm, fibrous capsule. It did not infiltrate the renal tissue or grow into the pelvis or calices. In one case, which had a small papillary cystadenoma, the fat had invaded the region of the tumor, but was separated from it by fibrous tissue.

CONCLUSIONS

Eleven cases of fat invasion of the kidney, or replacement lipoma, have been described here. In the first, fat invasion occurred in the absence of infection, pyuria and nephrolithiasis. This case is apparently unique. While there was no evidence of infection within the kidney there was slight evidence of perinephritis which was associated with fat invasion in all our cases. In all cases there was an increase in the perirenal fat, which was firmer than normal and surrounded the pelvis, entering the hilus around the vessels and pelvis and following the infundibula into the kidney. The pelvis was always imbedded in fat, and in some cases was com-

pletely obliterated. The fat evidently invades the kidney, carrying before it fibrous tissue membrane, filling in pre-existing spaces, invading the space between the cortex and the infundibula and calices and, where the hydronephrosis is present, surrounding and compressing this until complete obliteration has occurred in some places. In two cases in Group II, not associated with lithiasis, atrophy of the kidney had gone on to a remarkable degree. In the other cases in Group III atrophy of the kidney substance had occurred around the fatty replacement.

Replacement lipomatosis is related to the process commonly known as autonephrectomy. Most extensive fatty invasion has occurred in completely obstructed kidneys. Atrophy of kidney substance might be secondary to fat replacement, and cutting off of blood supply. Replacement lipomatosis becomes important clinically since this condition has been mistaken for renal neoplasm. It may account for the enlargement of kidneys in cases of upper urinary tract obstruction with or without the presence of stone. A different process in this condition, however, would lead to atrophy of a kidney and autonephrectomy.

Kutzman, in reporting a case of replacement lipoma of the kidney associated with stones, made a careful study of the literature, in which he found thirty-two cases (thirty-three with his own). The first report of this condition was made by Baader in 1778, in which at autopsy a fatty kidney was found associated with calculus. Two cases also associated with calculus were reported about fifty years later. During the nineteenth century twenty cases in all were reported. During the twentieth century only thirteen cases have been reported and of these eleven were discovered at operation, the first two being cases reported in 1901 by Israel, and the third one in which I operated in 1902. Since then operation has been performed in seven cases preceding this report. Kretschmer has recently reported a case. Among the thirty-three cases collected by Kutzman, only five were without stones, but these five were associated with pyuria and evidence of pyelonephritis. Our Case 1 reported here is the only one in which no evidence of either stone or intrarenal infection was present, as previously stated. In discussing the subject Kutzman says: "Replacement lipomatosis of the kidney is to be distinguished pathologically from fatty tumor in the kidney region. Some observers have either considered or

confused replacement lipomatosis with fat tumors of the kidney."

True renal lipomata are rare, infrequent in occurrence, and usually small in size, yellowish in color, found as encapsulated nodules, possess a fibrous capsule in the cortical layer distinctly beneath the fibrous capsule. They result from rests of fatty tissue which have become included in the kidney during embryonal life. Replacement lipomatosis possesses none of these characteristics.

Kutzman states that replacement lipomatosis of the kidney is always associated with kidney infection, usually intense and with calculous disease in 79 per cent of the cases. He thinks the process is probably one of invasion by the perirenal, peripelvic and hilus fat along the large vessels through the renal hilus, following a destruction of the renal parenchyma by calculosis and infection. That such an assumption is incorrect is very conclusively shown by our case.

I find in the literature an interesting article by Emanuel Seres in his Notas de la Cirurgia Renal, Seville, 1921. In this he refers to a case of Ransohoff, published in Keen's Surgery, in which a calculus was present and a similar case by Hartmann. Seres reports a case of a woman, aged forty, who had had severe pain in the left kidney with turbid urine in which nephrectomy was done, but the patient died later of pleurisy. Study of the specimen showed a thick fatty capsule, fat invasion of the hilus along the pelvis and calices with complete replacement of the renal parenchyma by fat. The ureter was dilated and evidence of chronic inflammation and pyelitis marked. Seres refers to other cases which are cited by Kutzman.

Thanks and sincere gratitude are due to Dr. Lloyd G. Lewis, who has assisted me greatly in the preparation of this paper, especially by his study and search for cases of lipomatosis among our museum specimens and the pathologic study of them, and also the literature. Without his great assistance this paper could not have been presented in its extensive form. Certainly some of the cases would have been missed. This interesting subject will be presented in greater detail in the forthcoming Volume III of Young's "Practice of Urology."

DISCUSSION

DR. ARTHUR L. CHUTE (Boston): I remember seeing, some years ago, a case of the sort that Dr. Young reported, but no careful study was made of it. This patient was seen with an older man. A mass several times as large as a normal kidney was removed which, I believe, went to the Warren Museum, and which, if I remember, was reported as a fatty infiltration of the kidney. I do not know of any further pathologic report on it. This mass was large enough so that one could feel it through the loin. Whether it was secondary to stone or anything of the kind, I do not remember.

DR. HERMON C. BUMPUS (Rochester, Minn.): I recall a case which had a history of hematuria. The pyelogram was very confusing as it was normal except for one calix which had a small hook-shaped deformity projecting from it. We diagnosed it as a renal tumor.

DR. ALEXANDER RANDALL (Philadelphia): We had a similar case this past winter, without paying the close attention to it Dr. Young has, carrying a complete replacement, with no renal tissue left, and occurring likewise in a kidney having stone.

I can't quite grasp, from what Dr. Young said, whether he considered the condition of lipomatosis primary or secondary. One time he speaks as though it had actual invasive qualities, and the next moment he speaks of its being a replacement process.

Does the fat invade renal tissue, or does it just compress and cause a starvation of renal tissue?

DR. H. A. FOWLER (Washington, D. C.): Dr. Young's very interesting contribution recalls one case which I might mention at this time.

In this patient we had an opportunity of following the case over a period of years. When he first came under observation, there was a stone in the left kidney, destroying the kidney to such an extent that nephrectomy was necessary.

Some years following that, he developed a lesion in the right kidney with a pyelonephrosis which required nephrotomy.

Subsequent to that, we did not see the patient for a number of years, until we were called and found the patient in uremia. He died promptly and on autopsy we were amazed to find that kidney transformed into a lump of fat. The whole kidney had been completely replaced, and we marveled that the patient was able to live with a kidney so completely destroyed by this infiltration of fat. The gross specimen was very firm in consistence and on section apparently no renal tissue could be made out, but just a lump of this fat.

DR. GILBERT J. THOMAS (Minneapolis): I would like to ask Dr. Young a few questions.

1. Concerning the character of the fat, was it different from the fat we find in the skin or we find around the kidney?
2. Did he notice any difference in the size of the blood vessels of the pedicle surrounded by the fat?
3. Was there any possibility of tuberculosis having anything to do with the nephrectomy?

DR. H. L. KRETSCHMER (Chicago): Dr. Young is to be congratulated upon his presentation of eleven cases of this rare and very interesting condition.

Fibrolipomatosis or substitution lipomatosis, or, as it is sometimes called, replacement lipomatosis, is not limited to the kidney. Similar substitution processes have been reported in the thyroid and in the muscle. A very interesting article on this subject was recently published by Dr. Le Count and Dr. Bacon of Chicago.

Although most of the cases are associated with stone and infection, and, rarely, tuberculosis, this condition may occur without these associated pathologic conditions. In some of the cases that Dr. Young showed, these co-existing pathologic conditions were absent. If this rare and interesting condition does occur without irritation such as might be produced by stone, or by infection, I think we must be careful how much of a factor we ascribe to the presence of stone and infection in its production.

I recently had the opportunity of reporting a case of this condition. The patient was a woman who developed a perinephritic abscess many years before I saw her. She was operated upon, the abscess opened and drained. A persistent discharging sinus in the loin remained for many years. A routine X-ray showed the

presence of a stone. I did a nephrectomy. The examination of the specimen revealed the presence of fat. This case was reported in detail in the April, 1932, issue of the Illinois Medical Journal.

Care should be exercised in differentiating between renal lipoma, perirenal lipoma, and replacement lipomatosis.

DR. HUGH H. YOUNG (Baltimore): In answer to the question as to what the etiology and the exact pathology is in this condition I can only say that it is always associated with an increase in the perirenal fat, which is firmer than normal, contains more fibrous tissue, surrounds the pelvis and invades the kidney around it, following the course of the blood vessels, pelvis and infundibula, and carrying with it a fibrous layer, which seems to encapsulate it, or separate it from the renal tissue, but not involving the papillæ. As the process continues to grow, the kidney cortex is made thinner and thinner until finally only a thin rim of cortex remains. In some cases this disappears completely.

As remarked in my paper the unique case in which there was no stone or renal infection present must be considered proof that the most important etiologic factor is invasion of fat through the hilus from the outside. In the case in which I had removed a stone by nephrectomy eight years previously there was no stone present, although catheterization showed infection of the kidney. It is probable, however, that the invasion in this case also occurred from the outside and led to gradual replacement of the cortex.

Although I saw my first case thirty years ago, and furnished an illustration of it for the Kelly-Burnam book on The Kidney, we have encountered only ten other cases since then. But as only thirty-five cases have been found in the world's literature, the condition must still be considered rare, and very remarkable in its etiology and pathology. Although rare, it is a very important renal condition, which should receive careful attention by urologic surgeons.

TRAUMATIC RUPTURE OF THE KIDNEY

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Washington, D. C.

Mr. S., aged sixty-two, a builder, was admitted to Garfield Hospital, October 15, 1931. The patient had fallen ten feet, striking his left side on an iron girder. Before I saw him he had been catheterized and bloody urine containing large clots was obtained. Doctor Merritt had already taken a flat plate that showed some enlargement of the kidney.

With Doctor Chadwick and Doctor Merritt I saw the patient in consultation about three hours after the accident. At this time he was fairly comfortable with no evidence of shock. He was passing very bloody urine containing large clots.

Physical examination showed respiration 18; pulse 78, of good volume, and temperature 98. Palpation of the left flank elicited some tenderness, but there was no definite spasm of the lumbar muscles. The kidney was indefinitely palpable and quite painful.

I felt sure, considering the condition of the patient, that no massive hemorrhage had taken place outside the kidney and I felt reasonably confident that we were dealing with an intra-capsular and not an extra-capsular rupture of the kidney, and advised against operation. The patient made a good recovery, the urine clearing of blood by the fifth day. Ten days after the accident Doctor Merritt took these pictures. Two months later the next group of pictures (showing slides) was taken.

I am sure that if any operation had been done on this patient, he would probably have lost his kidney, as the handling of it, traumatized as it was, would probably have resulted in producing an extra-capsular rupture which would have necessitated its removal.

The X-ray pictures are very interesting as they show so well the rapid repair and good function of a kidney that has been badly traumatized. The patient has been well since leaving the hospital.

RECURRING PYELONEPHRITIS AS AN ETIOLOGICAL FACTOR IN NEPHROLITHIASIS

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New York City

Case 1.—During March, 1930, a former patient, M. D., returned for examination, complaining of general malaise, with no urological symptoms and no pain or discomfort referable to any part of the body. She was a woman of forty-two who had been under my care three and one-half years before for an acute pyelonephritis involving the left kidney. This kidney, at that time, showed deficient function; the urine—pus and blood cells, colon bacilli, no crystals. The right kidney was negative. Under medical treatment and pelvic lavage, the infection subsided and on March 15, 1927, the urine from both kidneys was clear and cultures negative. Roentgenograms of the urinary tract at that time revealed no suspicion of calculus, and a left pyelogram was negative. From then until 1930 she had been well, at which time, the catheterized specimen of urine contained pus, blood cells, amorphous phosphates, and the cultures—streptococci. Cystoscopic examination showed a normal right kidney, very poor function in the left kidney, which was the source of the pus, blood cells, and bacteria. An X-ray revealed a large branching calculus completely filling the pelvis and calices of the left kidney. This kidney was removed, the patient making an uneventful recovery. The calculus was phosphatic.

Case 2.—The history of Case 1, together with the urological findings, was striking similar to a second patient. H. M., a woman of fifty-seven, then under my care, whom I had treated five years previously for a right colon bacillus pyelonephritis, with no evidence of urinary calculus, returned January 20, 1930, with no urinary symptoms, but on examination showed pus, blood cells and streptococci in an acid urine from the right kidney. The X-ray revealed a group of calculi in the right kidney pelvis. This kidney was removed. The calculi were composed of calcium oxalate and phosphates.

In view of the fact that these two cases, appearing simultaneously, presented such a clear parallel as regards clinical course and findings, and I had treated both patients through their original infections, proving the absence of calculi at that time, I decided to review a series of cases in which I had operated for nephrolithiasis, with the object in view of ascertaining the presence of a pre-existing pyelonephritis as a possible etiological factor in the stone formation.

From this review, twenty-one additional cases were found in which there was a definite history of pyelonephritis, in fifteen of which I had treated the patients during the original attacks, and in six the infection was treated by others. In each, the X-ray findings at the time of the original infection were negative, and all subsequently developed calculi.

Case 3.—M. B., female, aged forty-one, married, was the mother of three children. She had repeated throat infections; tonsils were removed in 1928. At this time, she was found to have pyuria. Cystoscopic examination showed bilateral staphylococcus albus infection—most marked on the left side—moderate nephroptosis. X-ray was negative for calculi. She was under medical treatment for eighteen months and pelvic lavage for six months, when the X-ray showed the presence of a calculus in the left kidney. Function of left kidney was then markedly impaired; urine alkaline, contained pus, blood cells and staphylococcus albus. Pyelogram showed advanced hydronephrosis with poor drainage, probably due to anomalous renal vessel. Left nephrectomy was performed December 12, 1929; an anomalous artery was found connected with the lower pole of the kidney, with the ureter looped over the artery. The calculus was phosphatic.

Case 4.—R. A., female, aged forty-two, married, was the mother of six children. She had a history of left renal infection in 1926. X-ray was negative for calculi. Urine contained pus, blood cells and colon bacilli. She was free from symptoms for two years, then developed hematuria. Cystoscopy November 12, 1929, showed urine from the left kidney acid, containing pus, blood cells and uric acid crystals, culture negative. X-ray showed calculus in the pelvis of the left kidney. Pyelolithotomy was performed November 27, 1929. Calculus was composed of calcium oxalate and urates.

Case 5.—M. C., female, aged fifty-three, married, mother of three children, was seen December 6, 1928. The patient was the wife of a doctor who gave an accurate history of her having had six years previously an acute left pyelonephritis which had been studied carefully by cystoscopic examinations; the left kidney had shown diminished function, pus cells and colon bacilli; X-ray was negative. There had been three recurrences of the infection, and when seen in 1928, she had a large pyonephrotic left kidney containing many calculi. The urine was alkaline, contained a sediment of pus cells, and the culture from this kidney showed enterococci. The kidney was removed. The calculi were phosphatic.

Case 6.—W. C., female, aged 28, married, mother of two children, was first seen in 1921, at which time she gave a history of a left pyelonephritis four years previously, during a pregnancy. X-ray was

negative for calculus. Two years later there was a second attack of pyelonephritis, also accompanying a pregnancy. X-ray was again negative. Cystoscopic examination May 13, 1921, showed a left pyelonephritis, the urine from this kidney containing pus, blood cells and enterococci, with diminished function. Two calculi were found in the left kidney pelvis and one in the left ureter. The latter was passed following manipulations, and the two calculi were removed from the left kidney by pelviolithotomy. The patient was next seen four years later following another pregnancy, during which she had had another attack of pyelonephritis—this time on the right side. Cystoscopic examination showed diminished function of the right kidney, pus, blood cells, and enterococci; X-ray showed a calculus in the right kidney. This calculus was removed by pelviolithotomy, and it, as well as the two in the left kidney and the calculus in the left ureter, was found to be composed of calcium oxalate. This patient has had three subsequent attacks of pyelonephritis, each followed several months later by the formation and passage of a calcium oxalate stone, the last during April, 1932. Her urinary tract is now free of infection and shows no calculi.

Case 7.—M. C., male, aged 53, single, seven years before coming for examination September 23, 1927, had a right sided pyelonephritis which subsided with treatment; X-ray was negative for calculi. Two weeks previous to examination he had pain in the right lumbar region, with hematuria. Cystoscopic examination showed a right pyelonephritis; the urine on this side was acid, containing pus, blood cells, calcium oxalate crystals, colon bacilli, and enterococci, with diminished function. The left urine was negative. X-ray showed two calculi in the right kidney pelvis, which were removed. They were composed of calcium oxalate.

Case 8.—The patient, male, aged fifty-nine, married, in 1928, following an acute enteritis, had a right pyelonephritis which subsided. X-ray was negative for calculi. Two years later hematuria developed. Cystoscopic examination revealed calcium oxalate crystals in the urine from both kidneys. The right kidney showed diminished function, with pus cells, and staphylococcus albus in an alkaline urine; X-ray showed a calculus in the pelvis of the right kidney, which was removed. It was composed of calcium oxalate and urates.

Case 9.—J. F., female, aged fifty-five, a widow, was seen January 5, 1925. She had a history of four attacks of right pyelonephritis during the past twenty years. She was last treated six months ago by a urologist, at which time the urine from the right kidney contained pus cells and colon bacilli; X-ray was negative. During November, 1924, the right kidney became enlarged and tender, she had chills and fever, followed by dysuria and frequency. Cystoscopic examination showed the urine from the right kidney acid, containing calcium oxa-

late crystals, pus, blood cells, and colon bacilli. X-ray showed a calculus in the pelvis of the right kidney, which was removed. It was composed of calcium oxalate and uric acid. Occasional pelvic lavage has kept the kidney free of infection, and the oxaluria has ceased.

Case 10.—The patient, male, aged forty-one, single, during 1919 was treated for right colon bacillus pyelonephritis, with relief of symptoms for four years, when he had a recurrence which disappeared under pelvic lavage and medical treatment. There were several recurrences during the next three years. In 1926, frequency, dysuria, and hematuria developed, and cystoscopic examination showed marked diminution of function of the right kidney; urine alkaline, contained blood and pus cells, and enterococci. X-ray showed the presence of a calculus in the pelvis of the right kidney, which was removed by pyelolithotomy. It was composed of calcium oxalate and phosphates.

Case 11.—T. C., female, aged fifty-six, a widow, for five years had intermittent attacks of right pyelonephritis which were controlled by medical treatment. In January, 1931, the patient developed pain in the right kidney region and hematuria. Cystoscopic examination showed diminished function of the right kidney, pus and blood cells in the urine from this side, and the cultures—staphylococcus albus. X-ray revealed the presence of a calculus in the upper calix of the right kidney, and two faint, irregular shadows in the region of the lower calix. At operation, a calculus firmly adherent in the upper calix was crushed and removed and the lower calix curetted. Subsequent cystoscopic examinations with pelvic lavage showed negative findings until one year later, when, after a lapse of six months, there was a recurrence of the infection in the right kidney, and X-ray showed that another calculus had formed in the lower calix. This calculus was removed. The composition was uric acid, calcium oxalate and phosphates. Subsequent examinations have been negative.

Case 12.—W. H., male, aged twenty-five, married, during August, 1924, had a right pyelonephritis—the urine from this kidney showing diminished function, pus and blood cells, and streptococci; X-ray was negative. Six months later he had severe pain in the pubic region. Cystoscopic and X-ray examinations showed pus, blood cells, and streptococci in the urine from the right kidney, a calculus 1 x 1.5 cm. in the right kidney pelvis, and a small calculus impacted in the left lower ureter. The latter was passed following intra-ureteral manipulation, and the calculus was removed from the right kidney January 10, 1926. With the elimination of the kidney infection there has been no recurrence of the calculi, the composition of which was calcium oxalate.

Case 13.—R. L., female, aged thirty-five, married, the wife of a physician, had recurrent attacks of bilateral colon bacillus pyelone-

phritis for ten years, without calculus formation. In November, 1922, she had suppression due to an impacted calculus in each ureter. These obstructions were relieved by indwelling ureteral catheters. The urine from each kidney was acid, showed pus cells, colon bacilli, and poor kidney function. X-ray showed multiple calculi in each kidney, as well as an impacted calculus in each ureter. This patient was under observation and treatment until July, 1929, when she died of uremia. During the seven years, she passed nine calculi from the right kidney and six from the left. The colon bacillus pyelonephritis persisted on each side—the urine, however, becoming alkaline and containing enterococci as well. Pelvic lavage gave relief of symptoms, but the kidney destruction was progressive. The calculi, which were at first composed of calcium oxalate, later became phosphatic.

Case 14.—J. M., female, aged forty-five, mother of two children, during 1923 had bilateral colon bacillus pyelonephritis with negative X-ray. Recurrences took place every few months until 1926, when first seen. Cystoscopic examination then revealed pus and blood cells in an acid urine from each kidney, diminished function on both sides, with colon bacillus on culture. X-ray showed a calculus in the pelvis of each kidney. The calculus was removed from the left kidney four years later, operation being advised because of obstructed drainage and progressive kidney destruction with sepsis. The calculus was composed of calcium oxalate and phosphates.

Case 15.—J. M., male, aged twenty-one, single, was first seen May 30, 1924. He had a history of bilateral pyelonephritis with intermittent attacks for two years. Urine was acid and had shown pus, blood cells, and colon bacilli during these recurrent attacks, with negative X-ray. One month previously had attack of pain in right lumbar region and in left lower quadrant. Cystoscopic examination showed an obstruction of the left lower ureter due to an impacted calculus, a bilateral colon bacillus pyelonephritis, acid urine, and a calculus in the pelvis of the right kidney. The calculus in the left ureter was removed by ureterolithotomy. It was composed of calcium oxalate. Subsequent medical treatment and pelvic lavage failed to clear the infection. Calculi continued to form and a right ureterolithotomy was necessary for the removal of a phosphatic calculus impacted in the right pelvic ureter. The urine became alkaline, and streptococci and staphylococci were found in abundance in the urine from each kidney. In 1927 a phosphatic calculus was removed from the left kidney, and in 1928 a phosphatic calculus was removed from the right kidney. Under continued pelvic lavage at regular intervals, the infection has been held in control and no calculi have formed during the past three years.

Case 16.—L. M., male, aged twenty-nine, married, was seen September 23, 1927. He had a history of left pyelonephritis verified by cystoscopic examination one year before, with negative X-ray. For one

month he suffered pain in the left costovertebral angle. Cystoscopic examination revealed diminution of function of the left kidney; the urine from this kidney was acid, contained pus and blood cells and colon bacilli. X-ray showed a calculus in the pelvis of the left kidney. The calculus, which was removed, was composed of uric acid. Under medical treatment and pelvic lavage at regular intervals, the infection has disappeared and there has been no recurrence of calculi.

Case 17.—F. O., female, aged forty-four, married, mother of two children, in May, 1924, had a right pyelonephritis—similar attacks having preceded this one six years and three years previously—the latter following a pregnancy. Cystoscopic examination revealed a double right kidney with infection in the upper pelvis. The urine was alkaline, contained pus, blood cells, and staphylococci, while the urine from the lower right pelvis and from the left kidney was negative. The urine cleared under medical treatment and pelvic lavage. There was a recurrence of the infection in July, 1924, which was again relieved by similar treatment. On December 3, 1928, following an attack of influenza, the patient developed pain in the right kidney region, and hematuria; the urine from the right upper pelvis showed pus, blood cells and enterococci. X-ray showed a calculus in the upper pelvis of the right kidney. The calculus was removed and found to be phosphatic.

Case 18.—H. R., male, aged forty-four, married, for five years previous to April, 1925, had repeated attacks of the left pyelonephritis, the urine showing pus and blood cells, diminished function of the left kidney and colon bacilli, with negative X-ray. In February, 1925, he had an attack of left renal colic. Cystoscopic examination showed blood and pus cells in the urine from the left kidney, diminished function, and the X-ray—a calculus in the pelvis of this kidney. The calculus was removed and found to be composed of uric acid and calcium oxalate.

Case 19.—J. S., female, aged thirty-two, married, in May, 1919, following a pregnancy, had a left pyelonephritis. The urine from this kidney contained pus and blood cells and colon bacilli. X-ray was negative. The symptoms subsided under medical treatment and pelvic lavage, to return three years later, at which time X-ray showed a calculus in the pelvis of the left kidney. The function of this kidney was markedly diminished, the urine contained masses of pus cells and colon bacilli. The patient was relieved of all symptoms following pelvic lavage, and refused operation. She returned April 14, 1932, with a branching calculus filling the left kidney pelvis and calices, and a functionless kidney, which was removed. The calculus was composed of calcium oxalate. No urine was obtained from the left kidney previous to operation.

Case 20.—H. V., male, aged forty-eight, married, in May, 1924, had a left pyelonephritis, with negative X-ray. The urine was acid, contained pus cells and colon bacilli. During January, 1925, the patient had four attacks of left renal colic. Cystoscopic examination showed blood and pus cells in the urine from the left kidney, and the X-rays —a small calculus in the pelvis of this kidney. The calculus was removed. It was composed of uric acid.

Case 21.—B. W., male, aged twenty-eight, married, had frequent attacks of right pyelonephritis over a period of eight years, to 1929. During these attacks, the patient's urine was alkaline, contained pus and blood cells and staphylococci. X-rays were negative until 1928, during which year the patient had four attacks of right renal colic, after each of which he passed a calculus. X-ray then showed a calculus in the pelvis of the right kidney. In November, 1929, the right kidney was removed. The pelvis and calices were filled with large phosphatic calculi.

Case 22.—S. W., male, aged fifty-two, married, in 1918, had a bilateral pyelonephritis, the urine from both kidneys being alkaline, containing pus, blood cells, staphylococci and streptococci; X-ray was negative. In 1920, an impacted calculus in left ureter was removed; it was composed of calcium oxalate and phosphates. Following this operation, the patient had several attacks of left renal colic, without passing a calculus. In 1926, he was found to have a left pyonephrosis with a calculus in the left kidney pelvis. In November, 1928, cystoscopic examination showed pus and blood cells in alkaline urine from both kidneys—staphylococci and calcium oxalate crystals in the urine from the right kidney, while the function of the left kidney was markedly diminished, the urine containing a sediment of pus, and the cultures showing staphylococci and streptococci. The left kidney pelvis and calices were filled with a large branching calculus. Under medical treatment and pelvic lavage, the function of the right kidney was markedly improved, the infection subsided, and the calcium oxalate crystals disappeared, while the pus and bacteria persisted in the urine from the left kidney. Left nephrectomy was performed in February, 1929. The calculus was composed of calcium oxalate and phosphates. Since this time, the infection in the right kidney has been under control, and the oxaluria has disappeared.

Case 23.—J. P., female, aged fifty-four, married, was seen February 7, 1930. Four years previously she had had a left pyelonephritis, with alkaline urine containing pus cells and staphylococcus albus; X-ray was negative. Two and a half years later, there was a recurrence of left pyelonephritis. X-ray showed calculus in the left kidney which was subsequently passed. Cystoscopic examination in 1930 revealed a left pyelonephritis, alkaline urine containing pus cells and staphylococcus albus. Right urine was negative. X-ray showed a diverticulum

of the left ureter which had a capacity of 4 ounces. Left ureteronephrectomy was performed.

Table I shows the reaction and organism found in the urine dur-

TABLE I

Case	Urine during pyelonephritis		Urine during recurrent pyelonephritis		Calculus
	Reaction	Organism	Reaction	Organism	
1	Acid	Colon bacillus	Alkaline	Enterococci	Phosphatic
2	Acid	Colon bacillus	Acid	Colon bacillus	Calcium oxalate and phosphates
3	Alkaline	Staphylococcus Albus	Alkaline	Staphylococcus Albus	Phosphatic
4	Acid	Colon bacillus	Acid	Colon bacillus	Calcium oxalate and urates
5	Acid	Colon bacillus	Alkaline	Enterococci	Phosphatic
6	Neutral	Enterococci	Neutral	Enterococci	Calcium oxalate
7	Acid	Colon bacillus	Acid	Colon bacillus	Calcium oxalate
8	Alkaline	Staphylococcus Albus	Alkaline	Staphylococcus Albus	Calcium oxalate and urates
9	Acid	Colon bacillus	Acid	Colon bacillus	Calcium oxalate and uric acid
10	Acid	Colon bacillus	Alkaline	Enterococci	Calcium oxalate and phosphates
11	Acid	Staphylococcus Albus	Alkaline	Staphylococcus Albus	Calcium oxalate (2) Calcium oxalate and phosphates
12	Acid	Streptococci	Alkaline	Streptococci	Phosphates and urates
13	Acid	Colon bacillus	Alkaline	Colon bacilli and Enterococci	Calcium oxalate and phosphates
14	Acid	Colon bacillus	Alkaline	Colon bacilli and cocci	Calcium oxalate and phosphates
15	Acid	Colon bacillus	Alkaline	Staphyococci and Streptococci	Phosphatic
16	Acid	Colon bacilli	Acid	Colon bacilli	Uric acid
17	Acid	Colon bacillus	Alkaline	Staphylococci	Phosphatic
18	Acid	Colon bacillus	Acid	Colon bacillus	Uric acid and Calcium oxalate
19	Acid	Colon bacillus	Acid	Colon bacillus	Calcium oxalate
20	Acid	Colon bacillus	Acid	Colon bacillus	Uric acid
21	Alkaline	Staphylococci	Alkaline	Staphylococci	Phosphatic
22	Alkaline	Staphylococci and Streptococci	Alkaline	Staphylococci and Streptococci	Calcium oxalate and phosphates
23	Alkaline	Staphylococcus Albus	Alkaline	Staphylococcus Albus	Phosphatic

ing the original attacks of pyelonephritis, as well as during subsequent attacks, and the composition of the calculus removed in each instance.

In sixteen cases, the urine was acid, and colon bacilli were present during the first attacks, in nine of which the urine subsequently became alkaline and cocci were the predominating organisms in the succeeding attacks. In five cases the urine was alkaline throughout the course of repeated attacks. In one case the urine was neutral, and in a second varied from faintly acid to faintly alkaline.

The calculi found in the cases maintaining an acid urine, with colon bacilli as the infecting organism, showed a predominance of calcium oxalate in their composition; two were uric acid calculi, while, in the cases presenting alkaline urine and cocci, the composition was largely phosphatic.

In these twenty-three cases the patients were, in every instance, subjects of chronic constipation. In twenty-one, foci of infection were found about the teeth, and in ten the tonsils were removed as possible foci. Chronic infections of the sinuses were present in seven.

In nine cases, a nephrectomy was carried out, a pelviolithotomy in nine, nephrotomy in one, a bilateral pelviolithotomy in two; pelviolithotomy was repeated in one case for a recurrence one year after the first operation, and in one other case (Case 13) there was no operation. The patient in this latter case, which ran a seven year course of lithiasis, during which time multiple kidney stones were passed, often following intraureteral manipulations and pelvic lavage, finally died of uremia. In Case 14, the patient died of uremia two years after the nephrotomy. In none of the nine cases in which a nephrectomy was done has there been a recurrence of calculi in the remaining kidney. In nine cases in which a pelviolithotomy was done there was one recurrence of a calculus in the operated kidney; one case had a recurrence in the opposite kidney, requiring a pelviolithotomy, and a second case had recurrences requiring a pelviolithotomy of the opposite kidney, as well as a bilateral ureterolithotomy.

These cases have all been under occasional observation since operation. Three of the nephrectomized patients having a bilateral infection before operation, have occasional pus cells and bacteria in the urine from the remaining kidney. None has crystals in the

urine. The patient in the case of bilateral pelviolithotomy has passed two calculi since the operations, but is now free of infection and crystals. The patient in the case of multiple operations on both kidneys and ureters still has a bilateral infection and has had pelvic lavage every four weeks up to the present time. Two other patients have had recurrences of subacute pyelonephritis, while the remaining patients are free of infection.

Every effort has been made in these cases to encourage elimination through the urinary and intestinal tracts, by means of diet, forced fluids, and exercise. Kidney lavage has been carried out in those cases showing pyuria and bacteriuria.

Much has been written concerning the etiology of renal calculi, and the possible rôle played in their formation, by infection, has been often disputed. It is a well known fact that many individuals, for long periods of time, pass urine containing a sediment of minute crystals of uric acid, calcium oxalate, and the various phosphates, without showing any tendency to stone formation. It is evident that changes in the urine which lead to a precipitation of crystals are not alone sufficient to bring about stone formation. The presence of a nucleus has been thought to be necessary for the formation of a stone, and on this theory clumps of bacteria, or the products of inflammation, *i.e.*, mucus, pus, muco-pus, or desquamated epithelium, have been suggested as possible nuclei for stones. Calculi have been reported as composed almost entirely of bacteria, as in the two cases of Scholl[2] in whose paper reports of ten similar cases are referred to.

The experiments of Rosenow and Meisser[1] in which calculi were produced in dogs following the infecting of devitaized teeth with streptococci cultured from the urine of a patient suffering from nephrolithiasis, are worthy of serious consideration.

That renal calculi are often formed in cases free of infection, and that many cases of extensive kidney infection show no tendency to stone formation is equally true.

One could not go so far as to suggest that inflammation plays an important part in all cases of calculus disease, yet, I believe that as an element in stone formation infection has not been given sufficient consideration along with the colloidal theory.

In the cases reported, the frequent change of an acid urine to alkaline, and of a superimposed coccal infection, followed by cal-

culus formation, is significant. The few recurrences of calculi (only one patient requiring a second operation on the same kidney) would seem to have been directly influenced by the clearing up of, or control of, the kidney infection through the elimination of foci of infection in other parts of the body, increased intestinal activity, forced fluids, kidney lavage, and urinary antiseptics.

The possibility of an intimate connection between recurring pyelonephritis and stone formation should lead to continued treatment and a careful follow-up of all cases of kidney infection with the hope of preventing calculus formation, also after the removal of renal calculi, to diminish the chances of recurrence.

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PROBLEM OF RECURRENT RENAL CALCULI WITH THE CONSIDERATION OF A NEW PREVENTIVE TREATMENT

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I wish to present a preliminary report of some work which I have been doing in an effort to avoid that unpleasant surgical sequence where, after the removal of a renal calculus, a recurrence of stone rapidly follows.

I believe we are now ready to agree that in the kidney, as in the bladder, calculus disease is no longer a disease at all, but a symptom. No matter how difficult a surgical problem may grow out of the presence of renal lithiasis, fundamentally, its permanent relief is not to be sought in the simple removal of the stone, but demands at the same time an appreciation and correction of the condition which allowed its formation. So let us look at the factors on which can be placed some reliance as being causative:

1. Urinary stasis takes its place in renal stone formation in equal force and importance as is granted to it in bladder stone. Faulty drainage and urinary stagnation form the essential preparation of the field, possibly present in an unappreciated large proportion of persons, and only awaiting the turn of events for the second link to be forged in the development of the chain of circumstances on which hangs the ultimate development of a calculus growth.

2. The problem of the chemical character of calculus formation becomes increasingly intricate as one delves into it. No one hypothesis can be stretched to fit all cases. We are practically forced to acknowledge that the chemical change that allows a pure uric acid calculus to form, must differ from that whence an oxalate stone crystallized. As the chemical results vary, so must the chemical cause.

3. The rôle played by infection must be separated into its component parts. If it can be proven absent, stasis and chemical changes remain to us. If it be present, it may be expected to vary its in-

fluence in accordance with the individual behavior of the specific organism's habits.

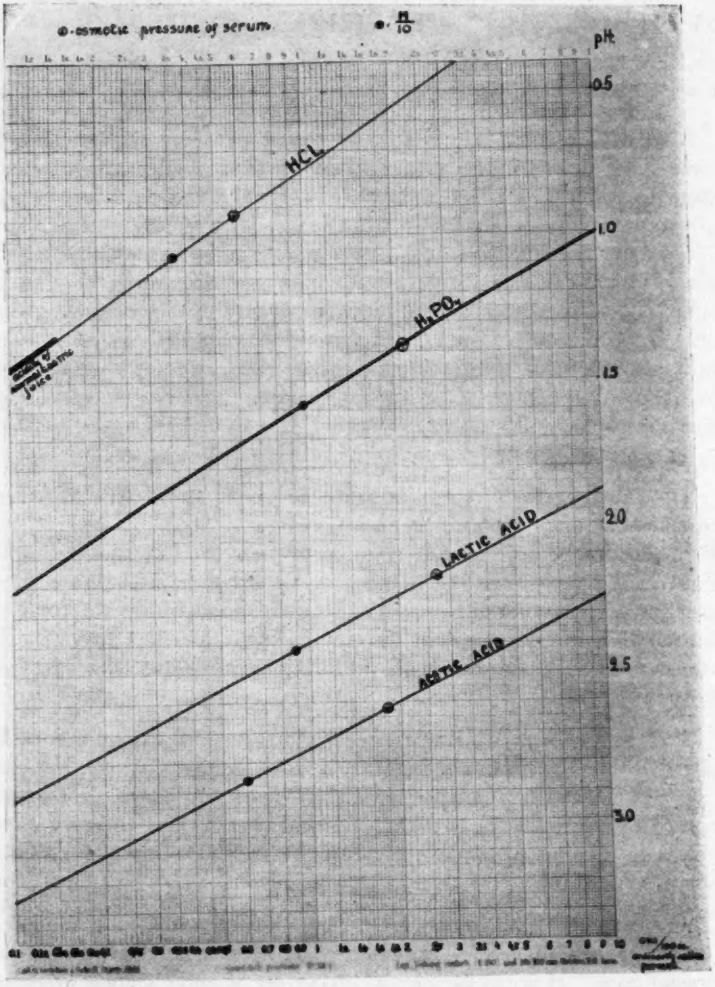


Fig. 1. Comparative curves of four weak acids. On right is the pH value or the acidity to which the tissue will be subjected. Below is the percentage strength or alkali binding capacity.

Testing these fundamental ideas against our experience with clinical cases has led me to feel that in one variety of stone we are apparently approaching some understanding of its causative factors. This is the so-called earthy, or triple phosphate stone.

Ever since Marcet and Sheele did their early chemical analysis of urinary calculi, we have recognized their observation that once the formation of deposits of triple phosphate takes place, it is very rarely superseded by other salts. Again, this variety is known to be the cause of both the large and the rapidly growing calculi. To these characteristics, I believe, can be added the observation that, once a triple phosphate stone is removed, subsequent stone formation will be of a similar chemical character. I believe these characteristics to depend upon the behavior of certain infecting organisms, and on this basis have evolved a step in preventive therapy, thoroughly tested in allied conditions in the lower urinary tract, checked by laboratory methods for efficiency and safety, and aimed to control and to prevent the infection responsible for this variety of stone.

It is recognized that bacteria often have a very limited range of chemical reaction in which they normally thrive. Change their cultural habitat in this one factor, and bacteriostatic, or bacteriocidal, action is obtained.

There is a recognized group of organisms which regularly produce, and then flourish in, an alkaline urine, and in this medium find a suitable habitat wherein they rapidly change urea into ammonia, with a resulting precipitation of the alkaline inorganic salts of calcium, magnesium and ammonia, of which the characteristic phosphatic calculi are formed.

In order to control this chemical change in the urine favorable for bacterial growth and phosphatic precipitation, we have carried out the following steps in our clinical material in an effort to obtain a prevention of the infection by changing the chemistry of the urine, and in so doing creating a habitat in which bacteria responsible for the same will not grow.

Our first step was in the treatment of suprapubic fistulæ following cystostomy with subsequent drainage. The picture is a familiar one of the post-operative prostatic patient, whose wound breaks down, creating a surgical menace that is a marked detriment to normal healing and closure. These wounds appear to be

essentially related to an alkalinization of the urine, and at their worst present an ugly, sloughing gangrenous sore on whose walls and even on the abdominal skin there is likely to be deposited encrustations of phosphates. Some time ago we experienced the ease with which such encrustations could be removed, in fact dissolved, by the topical application of a 5 or 10 per cent phosphoric acid solution. The response in healing following such local treatment is marked; a healthy wound rapidly follows the separation of the ugly slough, with the complete disappearance of phosphatic encrustations. Even in the absence of such breaking down of the wound, an ammoniacal odor appearing in the dressings, to the initiated is a warning that trouble is in store. Since adopting this step, the handling of such bladder cases by the topical application of this weak acid solution has made this complication gratifyingly infrequent.

The second step in our cliincal handling of these cases was in certain patients where, though the bladder wound was saved from the threatened breaking down, nevertheless, the constant threat of such a possibility was evident in the persistent pool of alkaline urine draining from the bladder. No amount of acidifying drugs by mouth appears to be sufficient in these cases to change the reaction of such an alkaline urine to a normal acidity, while topical applications to the fistula orifice fail of sufficient penetration to reach the bladder urine. It was in such a case, some time ago, that I first attempted a direct irrigation of the bladder cavity with a solution of 1 per cent phosphoric acid. To our surprise it became evident that the bladder not only tolerated this solution without discomfort, but even a stronger solution could be used without marked irritation being experienced by the patient. One or two such irrigations caused a prompt return of normal bladder urinary acidity, and this once obtained, it was easily held by the administration of the acidifying drugs by mouth.

This improvement in the handling of these cases has since become a routine in all our suprapubic cystostomies, and I feel it is a definite step in advance in controlling the possibility of postoperative infection with the type of organism which is recognized to have the above characterstics of both alkalinizing the urine and causing a precipitation of the earthy phosphates.

This finding in the lower urinary tract naturally led to our third

step in attempting to accomplish the same end in cases of recurrent calculi in the upper urinary tract. As stated before, these stone repeaters practically always form phosphatic stones, and with this in view, I wish to report to you our experiences to date in eleven cases in which we have irrigated the renal pelvis postoperatively with phosphoric acid solution. It is my hope that by so doing we can cause a sterilization of the infection with the organisms which have the above described characteristics if they be present, or be a prophylactic against their implantation. Such I feel to be a justifiable step towards the prevention of recurrent phosphatic calculus in the upper urinary tract.

In acidifying the urinary passages by irrigation, three qualities are desired in the acid chosen. It should not have to be used in a concentration which would have an osmotic pressure greatly above that of serum for so it would tend to irritate the mucosa by its dehydrating effect. It should have as high an alkali binding capacity as possible to minimize the neutralization by alkali or buffers in the cavity. It should have as high an acidity as the tissues will tolerate.

Phosphoric acid in concentration of 1 gm. per 100 c.c. is approximately 0.100 molar, has a pH about 1.5 to 1.6 and possesses 46 per cent of the osmotic pressure of the serum. This acidity, pH 1.6, is somewhat less than that of normal stomach contents after a test meal which, with a free HCl of 40, have a pH of about 1.4. A solution of hydrochloric acid having the same pH of 1.6 has a concentration of only 0.019 molar and hence has only one-fifth the alkali binding power of phosphoric acid at this same pH.

Lactic acid at a concentration of 2.7 gms. per 100 c.c. has an osmotic pressure equal to serum but a pH of only 2.2, about one-sixth as acid as phosphoric acid of the same concentration; indeed even at 10 per cent concentration the pH of lactic acid is only 1.9.

Acetic acid is still weaker and when at a concentration of 1.8 gms. per 100 c.c., which has an osmotic pressure equal to serum, its pH is only 2.6; even at 10 per cent concentration its pH is only 2.2. It has about one-thirteenth the acidity of a phosphoric acid solution of the same concentration.

It follows that both acetic and lactic acids are too weak to be suitable for an irrigating solution. On the other hand, a solution of hydrochloric acid will have this pH at so low a concentration

that it has only one-fifth the alkali binding capacity of the corresponding phosphoric acid.

Of these four acids only phosphoric acid fulfills the requirements for an irrigating solution with pH of about 1.6.

Experiments on dogs' kidneys have been performed and repeated by injecting the pelvis through the ureter from a laparotomy incision with a 1, 3 and 5 per cent phosphoric acid solution. One kidney was removed immediately, and the second one removed at the end of forty-eight hours. We have not been able to demonstrate, on microscopic study of these experimental dogs' kidneys, any evidence of damage to the pelvic epithelial lining or the renal papillæ; nor is there any evidence in these sections of any caustic action from the use of the drug in the above strengths.

CASE REPORTS

Case 1.—S. N., male, white, aged thirty-eight years. In September, 1925, the patient was suddenly taken with an attack of left ureteral colic. A diagnosis of left ureteral stone was made, and a left uretero-lithotomy was performed. Three months later, December, 1925, he experienced a dull pain in the right loin which was subsequently diagnosed as stone in the right kidney. He was again operated upon and seven small stones removed. Subsequent to this he voluntarily passed two small stones. For the next four years he had mild attacks of right penal pain, lasting from two to six hours. During this interval he was twice admitted to other hospitals for study, but on each occasion he refused operation, and apparently all that was done was a catheter drainage of the kidney, with the subsidence of chill and fever which had accompanied each attack. His first admission to the University Hospital was on July 17, 1930. Study showed a ureteral calculus in the lower third of the right ureter. After several attempts to aid the stone's passage, a right uretero-lithotomy was performed on July 25, 1930, under spinal anesthesia. Convalescence was uneventful and he left the hospital on August 12, 1930.

A follow-up cystoscopic examination, on September 8, 1930, showed no obstruction to the right ureter, though the pelvic urine was loaded with pus cells, and a lavage with 1 per cent mercurochrome solution was performed. The patient was re-admitted in November, 1930, remaining in the hospital four days for study. Diagnosis was right pyelitis, with an X-ray shadow suspicious of right renal calculus. He was again admitted to the hospital in January, 1931, for seven days, complaining of constant right-sided pain radiating down the line of the right ureter. At this time a purulent right pelvic urine was obtained. An X-ray plate suggestive of a shadow in the right kidney region was obtained, while low in the ureter appeared an oval shaped

shadow similar to that seen in the plates at the time of his right uretero-lithotomy. There was no obstruction to catheter passage, nor in the previous, or this admission had there been any fever.

The next admission of this patient was three months later, in March, 1931, when a more complete study was allowed and a recurrence of his calculus in the lower right ureter substantiated. Two operations were attempted at this time and both failed: the first, from an inability satisfactorily to expose the lower third of the ureter extraperitoneally; and the second, when this was successfully done, the stone was found to have migrated away from the field of attack. After further attempts at dilating the lower ureter in the hope that this stone would pass spontaneously, the final operation was performed in October, 1931, and the stone removed from the upper third of the ureter after fixing the same by an indwelling catheter. A tube was placed in the ureter up to the pelvis and the wound closed about it. The pelvis was daily irrigated with 1 per cent phosphoric acid and on one occasion a 3 per cent solution was used. There was no evidence of any local disturbance or pain, and when the tube was removed on the eighth postoperative day, primary closure of the wound rapidly followed. Following his discharge, the patient has reported regularly at intervals of two weeks for right pelvic lavage and ureteral dilatation. During his stay in the hospital, and subsequent to his discharge, he has been put on the regular administration of a dram of cod liver oil twice daily, and urged to continue a diet containing large quantities of milk and eggs. On January 8, 1932, his right pelvic urine was clear of pus, but still weakly alkaline. While on February 23, 1932, it was sterile to culture, and of a pH 6.5. On April 30, 1932, the right pelvic urine was still alkaline to litmus and had a pH of 7.4, while the left pelvic urine was acid to litmus and had a pH of 5.7. This case is still under observation. His recent calculus was composed of calcium and magnesium phosphate and calcium carbonate.

Case 2.—G. E., male, white, aged thirty-six years. The patient was admitted to the University Hospital, November 6, 1931. Diagnosis was calculus in the right renal pelvis. This calculus occurred in an intra-renal pelvis and at operation difficulty was experienced in getting sufficient exposure for the total removal of the stone, so that during traction the calculus broke and numerous fragments were obtained after careful search. A tube was inserted in the pelvis and the wound closed about the drainage. The pelvis was irrigated daily with a 1 per cent mercurochrome solution, alternating with a 1 per cent phosphoric acid solution. The tube was removed on the eleventh postoperative day. The patient was discharged on November 26, 1931.

Since the date of his discharge the patient has reported at two-weekly intervals for renal pelvic lavage with phosphoric acid and has been placed upon a diet rich in vitamin A, and cod liver oil in doses of dram one twice daily. On February 6, 1932, the catheterized specimen

was clear, and of a pH 5.8. On May 1, 1932, the right pelvic urine was acid to litmus and had a pH of 6.0. The calculus was composed of uric acid and calcium carbonate. Post-operative X-ray was negative for any evidence of fragments.

Case 3.—J. W. L., white, aged forty-two years The patient was first seen in June, 1919, at which time chronic prostatitis was present, and for which treatment was given at intervals for the subsequent four years. In 1923 dysuria with frequency developed and for the first time the patient reported the passage of four urinary calculi from the right kidney. In previous years, and at this study, his urine was found to be alkaline, with a definite infection in the right kidney pelvis. During the succeeding years, until September, 1928, numerous studies were made in an effort to determine the presence of tuberculosis; as well as an intermittent series of treatments for a persistent chronic prostatitis. During this time the bladder continued to get more and more intolerant, with a persistent alkaline urine and areas of marked ulceration. X-rays and pyelograms as early as February, 1923, had shown minute shadows in the lower calix of each kidney. These were felt to be calculi, but as they measured but 6x4 millimeters in size on the X-ray plate, no operative interference was advised.

Functional studies repeatedly showed the left kidney to have half the function of the right, and both diminished below normal. Three culture studies of the prostatic secretion remained sterile; while repeated studies for the tubercle bacillus (eleven in all) brought forth but one report of organisms suspected of being the tubercle bacillus.

In September, 1928, an acute right ureteral blockage required an immediate uretero-lithotomy in the upper third of the right ureter; recovery from which was prompt. The finding of the one positive culture for the tubercle bacillus, plus his persistent and aggravated cystitis, caused the advice for the patient to go into the southwest, and while in New Mexico, during the summer of 1929, two operations were performed a month apart for an acute ureteral calculus blockage on the left side. On his return, in the fall of 1929, X-ray examination revealed pocketed calculi in the lower calix of the right kidney, and two small but suspicious shadows in the region of the left kidney pelvis. On June 4, 1930, a second acute calculus blockage of the right ureter necessitated a second uretero-lithotomy to be performed on the right side in the upper third of the ureter. In November, 1930, a uroselectan study demonstrated the growth of the small shadows in both the right and left kidney pelves, but their size was no greater than could be expected to be passed in case dislodgment occurred. In fact, on numerous occasions, small calculi varying in size up to 5 millimeters in diameter were voluntarily voided, and during this time the bladder capacity rarely exceeded 4 ounces.

On November 28, 1930, a sizable soft stone was passed from the left ureter after a colic of a few hours duration. During the ten

months interval between November, 1930, and September, 1931, enormous growth of stone took place and a uroselectan study of September, 1931, showed typical coral calculi in both the right and left renal pelves. On November 2, 1931, a fall from horseback was sustained and five days later severe colic with complete right ureteral blockage occurred, again associated with alarming clinical symptoms of an infectious character. A catheter was successfully passed by the stone and pelvic drainage obtained, and on November 16, 1931, a third uretero-lithotomy was performed followed by a pyelotomy, with removal of the large pelvic stone; then a nephrotomy into the lower calix was done with the complete evacuation of the nest of calculi which had been observed there over a period of four years. (X-ray studies prior to this operation compared with the studies made two months before showed convincing evidence that the trauma sustained at the time of his fall had fractured the coral stone in his right kidney, a portion of which had caused the right ureteral blockage.) Drainage was instituted at this operation to both the pyelotomy and the nephrotomy incisions. This drainage was sustained for a period of three weeks and the pelvis was irrigated daily, alternating between potassium permanganate followed by mercurochrome, and a 1 per cent phosphoric acid. It is of especial note that the phosphoric acid caused no renal discomfort, but regularly produced a sense of burning, not unbearable, in the bladder. The drainage tubes were removed at the end of three weeks and the fistula closed four days later. X-ray on December 18, 1931, the date of discharge from the hospital, proved the right kidney negative for calculi.

Since his hospital discharge, the patient has reported at ten-day intervals for cystoscopic right ureteral catheterization and lavage. It is of importance to record that the first time in the period of eight or more years, the bladder has become tolerant of cystoscopy without sacral or spinal anesthesia. Its capacity has increased from 4 ounces to 14 ounces. The vesical lesions have retrogressed to a point where only an area possibly 1.5x2 cm. in size in the fundus of the bladder where the mucous membrane is still redundant, sodden and red. On January 12, 1931, urine collected from the right renal pelvis was brilliantly clear and weakly acid; while the bladder urine is still alkaline. Catheterization on January 28, 1932, showed the right kidney pelvic urine to have a pH of 5.8; while culture showed, on March 28, 1932, from the right side, an organism closely related to encapsulatus pneumonia and B. atrosepticus, and a pH 6.2; and from the left side (still stone-bearing) a similar infection, and a pH 7.6. The last stone removed from the right kidney was composed of calcium and magnesium phosphate, calcium oxalate, and calcium carbonate.

Case 4.—C. S., male, aged twenty-nine years. The patient was admitted to the hospital February 26, 1932, complaining of attacks of pain in the left loin and left abdomen. These symptoms have been

present at intervals over the past six years. X-ray showed a calculus in the upper third of the left ureter opposite the lower pole of the kidney. On March 2, 1932, an indwelling catheter was placed to the renal pelvis, following which a left uretero-lithotomy was performed under a spinal anesthesia. The stone was found just below the uretero-pelvic junction and the ureteral wall markedly thickened. Incision of the ureter failed to find the stone, and incision was enlarged to the pelvis through which the stone was found in the lower calix and removed *in toto*. A No. 16 F. catheter was passed down the ureter and the same closed about it, bringing it out through the posterior pelvic wall. A larger tube drain was placed in the pelvis through the same pelvic opening. Through the drainage tube the pelvis was irrigated daily with a 1 per cent solution of phosphoric acid. The tube was removed on the seventeenth postoperative day. Two months later, on April 30, 1932, urine collected from the left renal pelvis was strongly acid to litmus, and gave a pH reading of 5.3. On analysis the stone was found to consist of calcium carbonate and sodium urate.

Case 5.—S. D., female, aged fifty-seven years. The patient was transferred from the Medical Service and found to have huge bilateral stag-horn calculi in either renal pelvis. She suffered particularly from pain in the right loin and seemed quite weak and lethargic. An indigo carmine test appeared from the right ureter in 14 minutes, and from the left ureter in 10 minutes, but with only fair concentration of the dye. Phenolsulphonephthalein test gave 20 per cent for the first hour; 10 per cent for the second hour. Blood urea nitrogen was 24 mm. per 100 c.c. Operation was performed on February 24, 1932, and a large stone was successfully removed from the right kidney pelvis, by a pyelolithotomy, and a large drainage tube was placed through a nephrotomy incision. The patient received a daily irrigation of the renal pelvis with 1 per cent solution of phosphoric acid during twenty postoperative days, at the end of which time the tube was removed. One week after this operation her blood urea nitrogen was 27 mm. per 100 c.c. On March 13, the blood urea nitrogen was 19 mm. per 100 c.c. On March 22, the blood urea nitrogen was 26 mm. per 100 c.c. Her convalescence was uninterrupted, though she went home, on March 24, against our advice and before complete healing was accomplished. Subsequent observations have not been obtainable. Analysis of the stone showed it to consist of calcium carbonate and triple phosphates.

Case 6.—F. T., male, aged forty-four years. The patient entered the hospital December 3, 1931, complaining of left loin pain. Sixteen years ago the patient suffered a similar attack which was relieved by a hypodermic, and there is no record of a stone being passed. Four months prior to admission he was seized with a severe left abdominal pain which was again relieved by a hypodermic of morphia, and a

third attack of similar colic occurred five days before admission, continuing to date of admission. X-ray study revealed a stone in the lower third of the left ureter, measuring 8x6 mm. The catheter was obstructed at 8 cm. from the ureteral orifice. The urograms showed no evidence of pelvic back pressure. Nineteen days were consumed in various attempts at cystoscopic reduction and removal. This being unsuccessful, a uretero-lithotomy was performed on December 23, 1931, and a solitary stone removed. A catheter drainage was placed to the pelvis through which, on one occasion only, a 1 per cent solution of phosphoric acid was instilled. This drain was removed on the fourth day, and on four occasions, postoperatively, the renal pelvis was irrigated at two-weekly intervals by cystoscopic ureteral catheterization. The stone was not analyzed, but has the appearance of a calcium oxalate calculus.

Case 7.—M. G., female, aged fifty-one years. This patient was admitted to the service of Dr. F. E. Keene on December 13, 1931. She entered the ward with a permanent right nephrostomy sinus. Her previous history recounts an appendectomy, a left nephrectomy for stone, an oöphorectomy, a right nephro-lithotomy, and later an operation for bladder ulcer and a permanent drainage for a recurrent calculus pyonephrosis of the remaining right kidney, which was performed July 6, 1930. She was in a critical condition from renal insufficiency, and her sinus tract was coated with phosphatic concretions. X-ray showed numerous irregular shadows extending down the sinus and involving the remains of a large pyonephrotic kidney. Her urinary drainage was strongly alkaline with a typical ammoniacal odor. After X-ray studies and various local measures had been tried, irrigations of the sinus tract with 1 per cent phosphoric acid solution was started on February 28, 1932. These were continued daily for five days without apparent discomfort, and with marked improvement in the wound's condition. The patient died suddenly of cardiac failure on the night of March 3, 1932. Analysis of the calculus showed it to be of typical triple phosphates. This should have been a test condition in which to obtain an ideal therapeutic result, and it is regrettable that sudden death defeated the outcome.

Case 8.—H. H., male, aged forty-three years. This patient was admitted to the hospital March 2, 1932. History recounts a previous left pyelolithotomy for two renal calculi. The patient had suffered soreness and pain in the left side for the past three years. X-ray examination revealed two stone shadows in the left pelvis; while urograms showed one to be in the left renal pelvis, and the other in the lower major calix. Operation, performed on March 9, 1932, demonstrated a stricture at the uretero-pelvic junction, through which the incision was carried, and two large stones were removed through this pyelotomy opening. A nephrotomy was performed through the lower major calix and tube drainage brought into the pelvis. Pyelotomy in-

cision was closed about a No. 12 rubber catheter inserted down the ureter and the same brought out through the nephrotomy wound with plastic reconstruction of the uretero-pelvic junction. Daily irrigations with a 1 per cent solution of phosphoric acid were carried on through the drainage tube for seventeen days; the pH of the pelvic urine remaining at 6.0. The tube was removed on the seventeenth day. Convalescence was uncomplicated. Culture of the urine showed Bacillus coli communis. Analysis of the stone revealed it to be of calcium carbonate and sodium urate.

Case 9.—J. A., male, aged twenty-eight years. The patient was admitted to the hospital April 4, 1932, complaining of pain in the right side of the abdomen. There had been no previous operations. Study revealed a large calculus in the right renal pelvis, which was moderately hydronephrotic. An operation was performed on April 6, 1932, at which time a large stone was removed by a right pyelolithotomy, with a tube drainage to the renal pelvis. Irrigations of a 1 per cent solution of phosphoric acid were carried on through this tube every other day for three applications. The tube was removed on the sixth post-operative day. Convalescence was uncomplicated. Analysis of the stone showed it to be of calcium carbonate.

Case 10.—S. F., male, aged forty-three years. This patient was admitted to the hospital March 9, 1932, complaining of pain in the right renal region of six months' duration. Study revealed a stone of elongated shape filling a small intra-renal pelvis and plugging the uretero-pelvic outlet. Operation was performed on March 16, 1932, and the stone removed through a small pyelotomy incision. The only obstruction demonstrated was the adhesion of the ureter to the lower pole of the kidney, with moderate distortion of its course. A small rubber catheter was placed as a drain, through which a daily irrigation of 1 per cent phosphoric acid solution was carried on for the following five postoperative days. Analysis of the stone proved it to be of calcium carbonate, sodium urate and uric acid. Convalescence was rapid and uneventful. On May 5, 1932, the right pelvic urine was found to be clear with a pH of 6.0.

Case 11.—H. B., aged twenty-eight years, was admitted to the hospital April 1, 1932, complaining of right loin pain. This patient had been carefully studied before admission and all evidence pointed to the fact that he had a congenital absence of the left kidney, with a large stag-horn calculus in the pelvis and lower calix of the solitary right kidney. Operation was performed on April 12, 1932, and after a large pyelotomy incision was obtained, the calculus unfortunately broke on attempted removal. The portion remaining was impacted in the lower calix. A nephrotomy was then performed over this point and the fragment was successfully removed.

Reconstruction of the stone suggested that a third fragment was absent, though thorough search at operation and copious lavage of

the pelvis failed to detect it. A large tube drain was placed through the nephrotomy wound to the pelvis and bleeding was controlled by a mattress suture on either side of it. No repair of the pyelotomy incision was attempted. Five days after operation, X-ray study revealed a fragment 7 mm. in diameter apparently lying in the pelvis 3 cm. from the end of the drainage tube. Before obtaining an analysis of the stone an attempt was made to dissolve this fragment by intermittent irrigations of 1 per cent solution of phosphoric acid. This was accomplished by passing a ureteral catheter through the lumen of the drainage tube into the renal pelvis. This catheter was connected through a Murphy drip with a transfusion burette, and for the subsequent fourteen days irrigation with 1 per cent solution of phosphoric acid was run through this at intervals of an hour on and an hour off. No discomfort was experienced except occasionally, when the patient voided small quantities of urine there was a feeling of slight burning in the bladder and urethra.

At the end of two weeks X-ray study failed to reveal any change in the stone's size, and a second small shadow was observed in the upper calix. A comparison of this plate with the one taken five days after operation (the latter having been taken in bed without preparation, and not as clear as could be desired) showed that this second shadow was probably likewise present in the earlier plate too. Failing of dissolution of the stone, an alligator forceps was passed through the drainage tube and the larger and lower stone was successfully removed with the tube at one time. Feeling somewhat uncertain of the smaller shadow in the upper calix, the wound was allowed to heal and the patient voided a small stone without colic four days after the removal of the other stone. Analysis of these stones proved them to be of calcium carbonate and calcium oxalate.

SUMMARY

1. Phosphoric acid 1 per cent has a pH acidity of approximately 1.6. Its bacteriocidal value is based thereon.

2. Phosphoric acid 1 per cent is practically isotonic and is slightly less acid than the gastric acidity after a test meal.

3. In experimental dogs, renal pelves injected with 1, 3 and 5 per cent phosphoric acid fail to show any destruction of pelvic lining epithelium, or damage to renal papillæ.

4. Eleven patients in whom renal pelvic lavage with 1 and 2 per cent phosphoric acid solution has been used, either through postoperative drainage tube, through ureteral catheter, or both, have not experienced discomfort or excessive renal pain. The bladder is less tolerant than ureter or kidney pelvis, and the urethra is the least tolerant of all.

No.	Name	Operations	Chemistry	Pelvic lavage	Drain removed	Ureteral lavage	Final studies
1.	S. N.	1. L. Uretero-lithot. 2. R. Nephrolithot. (Voided calculi) 3. R. Uretero-lithot. 4. R. Uretero-lithot.	Ca. and Mg. Phos. Ca. Carbon.	Daily 1% sol. phosphoric acid Once 3% sol.	8th postoperative day	Every 2 weeks	4 months later R. pelvic urine pH 6.1 7 months later R. pelvic urine pH 7.4, L. pelvic urine pH 5.9
2.	G. E.	1. R. Pyelolithot.	Uric acid Ca. Carbon.	Q. 2. d. 1% sol.	11th postoperative day	Every 2 weeks	6 months later R. pelvic urine pH 6.0
3.	J. W. L.	1. R. Uretero-lithot. 2. L. Pyelolithot. 3. L. Pyelolithot. 4. R. Uretero-lithot. 5. R. Uretero-lithot. R. Pyelolithot. R. Nephrolithot.	Ca. and Mg. Phos. Ca. Oxalate Ca. Carbon.	Q. 2. d. 1% sol. Once 2% sol.	21st postoperative day	Every 3 weeks	5 months later R. pelvic urine pH 5.8 Has coral calculus in L. pelvis
4.	K. S.	1. L. Pyelolithot.	Ca. Carbon. Na. Urate	Daily 1% sol.	17th postoperative day	None	2 months later L. pelvic urine pH 5.3
5.	S. D.	1. R. Pyelolithot.	Ca. Carbon. Triple Phos.	Daily 1% sol.	20th postoperative day	None	
6.	F. T.	1. R. Uretero-lithot.		Once 1% sol.	4th postoperative day	Every 2 weeks	
7.	M. G.	1. L. Nephrolithot. 2. R. Nephrolithot. 3. R. Nephrolithot. permanent drain	Triple Phosphate	Twice daily for 4 days	Not removed	None	Encrusted nephrotomy sinus Strong ammoniacal odor Uremia Death
8.	H. H.	1. L. Pyelolithot. 2. L. Pyelolithot.	Na. Urate Ca. Carbon.	Daily 1% sol.	17th postoperative day	None	
9.	J. A.	1. R. Pyelolithot.	Ca. Carbon.	Q. 2. d. 1% sol.	6th postoperative day	None	
10.	S. F.	1. R. Pyelolithot.	Ca. Carbon. Na. Urate Uric acid	Daily 1% sol.	5th postoperative day	None	2 months later R. pelvic urine pH 6.0
11.	H. B.	Congenital solitary kidney 1. R. Pyelolithot. R. Nephrolithot.	Ca. Oxalate Ca. Carbon.	Every other hour for one hour 1% sol.	23rd postoperative day	None	Fragment in pelvis postoperatively Attempted to dissolve same to no avail Removed with forceps on 23rd postoperative day

5. The renal pelvic urine in recorded cases has been re-studied and with one exception has been found to retain a normal acidity following this postoperative lavage.

6. This step in prophylactic treatment in cases of recurrent renal calculi has a rationale in both co-related conditions in the lower urinary tract and in bacteriologic findings.

CONCLUSIONS

1. By bladder lavage with phosphoric acid postoperatively, alkalinization and phosphatic encrustations can be prevented.

2. The treatment of staphylococcic cystitis, encrusting cystitis, leukoplakia and allied conditions by this means is indicated.

3. The prevention of recurrent renal calculi of the phosphatic variety is being attempted with every indication of success.

4. The possible dissolution of small phosphatic calculi, or fragments left at operation, may be expected by the recognized action of such strengths of phosphoric acid *in vitro*, and the tolerance of such topical applications *in vivo*.

5. As a postoperative prophylactic measure against infection with the alkali-producing organisms, it is herein proven safe and efficacious in kidney surgery and should therefore aid in the prevention of recurrent renal calculi of the phosphatic variety.

IMPROVED FORCEPS FOR THE REMOVAL OF RENAL CALCULI

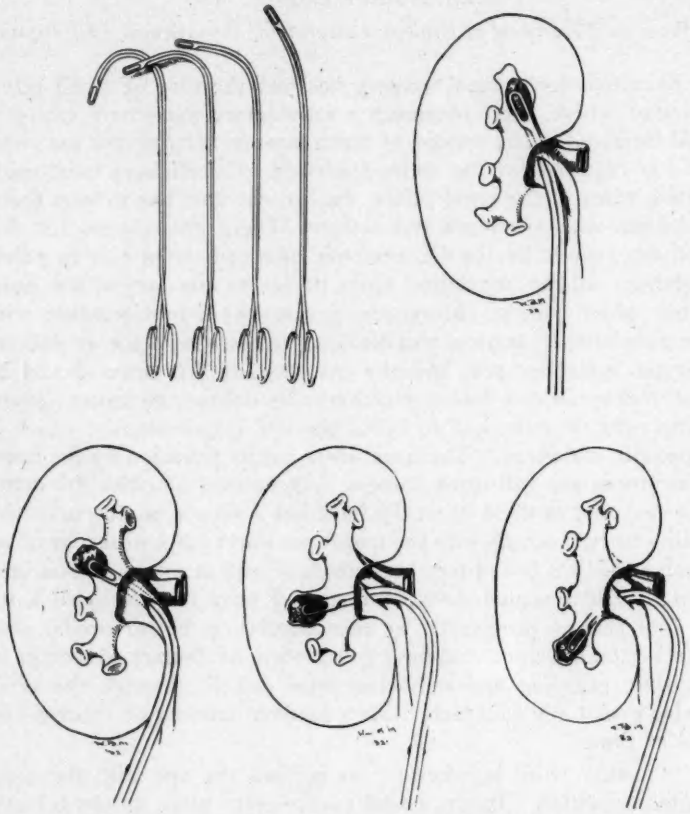
ALEXANDER RANDALL, M.D.

From the Department of Urology, University of Pennsylvania, Philadelphia

Everyone doing renal surgery has met the case of small pelvic calculus where, after obtaining a satisfactory pyelotomy exposure and incision, he has wasted as much time in groping for the stone as was required for the entire approach. Calculi have most fickle habits when in the renal pelvis, and to win, one has to woo them, at times, with every art and artifice. There are reasons for this and the answer lies in the anatomic approach from loin to pelvic opening, and the angulation from thence to any one of the usual three major calices. Moreover, gentleness in manipulation with the avoidance of trauma and bleeding are essentials for an uncomplicated convalescence, and the grasping of the stone should be followed by an easy line of traction in its delivery to insure against unnecessary trauma and to avoid possible fragmentation, which is especially undesired. The usual instruments provided by the operating room are gall-stone forceps (adaptations of older lithotomy forceps) and as these generally have but a simple, slight curve, the ability to reach easily into the middle or lower calix in search of an elusive calculus is at times both abortive and vexatious. For such reasons and repeated disappointments, I have had designed a set of four clamps, progressive in their angulation, but of similar construction and weight, and have found them of distinct advantage in locating, grasping and removing renal calculi, through the preferable pyelotomy approach, with a minimal amount of trauma and loss of time.

A further word is necessary as regards the one with the most acute angulation. It was found necessary to place its pivot 1 cm. nearer the handle than in the other three in order to get a proper opening of the blades, and then finding that the curved portion would bow-open in greater proportion than the tips of the blades, and to a degree that would possibly stretch pelvis or pelvic incision unnecessarily, a slight over-riding of the curved portion is purposely introduced when the blades are closed.

Both this curve and the next one to it have been kept definitely longer in the blades than would be necessary for work in the pelvis only, and this has been done so that they may be used for the additional purpose of making a nephrotomy stab puncture from



within outward, through a lower calix and then utilized to draw into the pelvis tube drainage when such is desired.

The standardization of curve and shape has been accomplished through the coöperation of Charles Lentz & Sons, Instrument Makers, Philadelphia, Penna.

DISCUSSION

Dr. Francis S. Watson (South Dartmouth, Mass.): Mr. President, it is not altogether appropriate, but I would like to mention that in the work for which Dr. Watson and Dr. Cunningham are responsible, which nobody would recognize today as belonging to the present era, there is mention of the occurrence of rupture of the kidney from very unusual and slight causes. There are in this series of cases—about a dozen—several in which the injury was produced by muscular action on the part of the patient only.

In one case, a man was boxing, struck at his opponent, and in so doing ruptured his kidney. Another man was dancing with a woman said to be his wife, and he clasped her with such enthusiasm that he ruptured her kidney. Another was a man who was carrying a sack on his back and going under an arch. The arch was too low; in stooping suddenly to avoid the arch, he ruptured his kidney. There were thirteen cases of ruptured kidney in the series produced by very slight injuries, and most of them by muscular action alone.

My own case was a woman who, in making a sudden downward movement, trying to close a window which had become stuck, ruptured her kidney.

I think this class of case is not very commonly known, even by urologists, and that one reason for their not being known is because they are published in the archives already referred to.

Dr. William F. Braasch (Rochester, Minn.): Our experience would corroborate that of Dr. Bugbee in that chronic pyelonephritis is frequently accompanied by stone. As a rule stone secondary to chronic pyelonephritis is small. Very often there are multiple stones scattered in the cortex and not causing much trouble.

The bacteria usually found with this condition are as rule urea-splitting, be it staphylococcus, colon bacillus or proteus ammoniæ. Staphylococci are found most frequently in these cases. The combination of ketogenic diet and acidification of the urine is of value in controlling such infection when the colon bacillus is present. We have employed a 2 per cent solution of phosphoric acid in the treatment of incrusted cystitis, as suggested by Dr. Randall.

Dr. George R. Livermore (Memphis): Work is being done in the chemical laboratory of the University of Tennessee by Dr. A. R. Brist on a Vitamin A deficiency diet. The work is under way, but is insufficient to report at present. Dr. Brist had three white rats die within eighty days on a Vitamin A deficiency diet, and in all three of them he has found the bladder filled with numerous small calculi.

He is going into the chemistry of these calculi as well as whether a return to a Vitamin A diet will cause the disapperance of the calculi, trying to get the whole problem worked out.

I hope to have a further report for you next year.

Dr. W. E. Lower (Cleveland): I think we all appreciate the importance of having some method of preventing the recurrence of renal calculi. It is very gratifying and promising in these unsolved problems, of which the formation of stones is one, to have such work as Dr. Randall has presented here today. I feel quite hopeful that we are going to solve the problem eventually.

Dr. Hagner did not tell us anything particularly new, as Dr. Watson said, when he reported that case of rupture of the kidney. I think, however, he contributed something worth while when he showed us the way of preventing or correcting the deformities in cases of congenital absence of the spongiosum. I would like to inquire how long he leaves in the trocar and whether this is done before he makes any attempt to restore the urethra. It looks like a promising procedure. I hope it will work out practically, and as well as it looks on the board.

Dr. Hugh H. Young (Baltimore): The subject of recurrence after operation for renal and ureteral calculi is very important, as the great clinics of the country report recurrence in from 20 to 40 per cent of the cases.

Briefly stated the cause of the recurrence is one of the following: Missing a calculus or leaving a fragment; persistent infection; dependent or badly draining calices or pouches; obstructions at the uretropelvic juncture. If the stone lies within a calix or pouch which has excellent drainage, removal of the stone by pyelotomy will usually be the method of choice, and can be expected to give good results, if one is careful to sterilize the urine before allowing the patient to leave. If the infecting organism is a coccus, novar-

senobenzol, in doses from 0.30 up to 0.75 intravenously, at intervals of three to four days, will usually give quick results. With bacillary infections it is more difficult to obtain sterilization, and various treatments by mouth and intravenously may be required in addition to pelvic lavage.

When the stone is in a dependent pouch with uphill drainage, and especially if the infundibulum leading from the pouch to the pelvis is contracted, the stone can not usually be removed by pyelotomy. In preference to nephrotomy, I generally carry out resection of that pole of the kidney, unless contraindications exist. I proposed this method a number of years ago in cases of this character, and have been greatly pleased with the results obtained. We have recently studied seventeen cases, fourteen of which were resections of the lower pole, and three of the upper. There has not been a single recurrence of renal or ureteral calculus in any of these cases. The operation is, I think, greatly to be preferred to an extensive nephrotomy, which leads to marked destruction of kidney tissue from the multiple sutures, required to stop the bleeding. By thus removing the stone-bearing area, and the poorly draining pocket, if one continues to treat the patient until sterile urine is obtained, recurrence of calculi will, in my opinion, rarely occur.

Dr. Alexander Randall (Philadelphia): I was trying to recall one further point in the case I showed you that I thought was particularly interesting. There had been many observations over a period of eight years and the bladder capacity was never over 4 ounces. It is interesting that following renal lavage with phosphoric acid, which was kept up for twenty-one days, each time the pelvis was injected the patient would get his greatest sensation of discomfort in the bladder. His wounds closed in four days, after drainage was removed, and since that time he has had a perfectly tolerant bladder, and a capacity which he time and time again has measured to be 14 ounces. Naturally he got night comfort. I have four times made cystoscopic examination of this patient without the slightest anesthesia, a thing that has been absolutely impossible in the past.

This case was the reverse of another I mentioned, where we have been able to acidify the operative side and yet consistently the remaining stone-bearing left side carries an alkaline urine.

I think the pelvis of the kidney has been an organ to a degree neglected. We have seemed to hesitate to work in the pelvis the way we would with similar conditions in other organs. I think the time is ripe when we should begin to do more intrapelvic work and, under proper guidance, I don't doubt that it will be made safe.

Secondly, this method I think has its greatest importance as a prophylaxis against infection and should be used, as I will consistently continue to use it, in every stone case, whether it happens to be a phosphatic stone or not, because too often the phosphatic-forming organisms come in after the operation to give a second stone of different chemical characteristics.

SECOND DAY, MAY 27, 1932

WHAT DOES RADIUM DO TO THE MALIGNANT PROSTATE?

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The methods commonly employed in the treatment of cancer of the prostate are five in number. Probably the one most frequently used is an attempt at suprapubic enucleation; generally the diagnosis has not been made, and the surgeon, much to his dismay, finds a hard fibrous feeling gland without lines of cleavage. He may be able to remove a small amount of tissue, or, if there is a co-existent hypertrophy of the lateral lobes, he can, by enucleation of these lobes, restore temporarily the patency of the bladder neck. Another way of removing the obstructing portion of the gland is by means of the resectoscope or the punch, or by a partial perineal prostatectomy. A third method, followed by those of a naturally pessimistic disposition, is to do nothing except advise the use of the catheter, or, if that is impossible, to institute permanent suprapubic drainage.

The purpose of all these methods is solely to relieve urinary obstruction; the possibility of curing the disease or of preventing the recurrence of obstruction is disregarded. This is not the case with total prostatectomy, which has for its aim the complete removal of the malignant growth, or with the use of radium, the purpose of which is to bring about the destruction of the cancer *in situ*, or at least a marked diminution in its malignancy.

This paper is concerned only with the last of these methods; it is an inquiry into the actual results which are brought about by the use of radium introduced into the malignant prostate gland.

There is wide diversity of opinion among urologists as to the value of this form of treatment. Without attempting to classify the views of all who have written upon this subject, we would like to refer to a few definitely expressed opinions. Barringer,[2] in a paper read in Boston in 1928, said that from 5 to 10 per cent of cases of prostatic carcinoma can be controlled by radium sufficiently well to lead us to think that the patient is cured. Of 202

cases reported by him, thirty patients were alive three or more years after treatment. Cunningham[3] has never seen a patient of this type cured by radiation; of fourteen patients treated by radium inserted through the perineum, a large majority died within two years. Among the French urologists, Legueu[1] has discarded radium treatment in cancer of the prostate and Marion finds his results unsatisfactory, while Chevassu[1] employs radium with the hope of seeing good results, and Papin[1] uses it in cases unsuited for perineal prostatectomy.

As a preliminary to the discussion of the results obtained by the writer in radiation of the malignant prostate, it is worth while to consider what is known of the effect of radium on malignant tissue in general. Familiarity with the basic facts of radium therapy is essential for those who would use this method.

An excellent summary of the known facts about the action of radio-active substances on living cells and tissues is given by Leo Loeb[5] in the Journal of Cancer Research of October, 1922.

Tumor cells, Loeb says, are more sensitive to radiation than the majority of tissues. Regaud has shown that cells in process of mitotic division are especially sensitive to radiation. The destruction of cancer cells is often preceded by irregularities of mitotic division, by formation of giant cells and nuclei, by cessation of mitotic activity, by swelling of nucleus and cytoplasm, by pyknosis and vacuolization of cells. The cancer cells which disappear are supplanted by growing connective tissue which invades the parenchyma, subdivides it and later replaces it. Under the influence of radiation, rapidly growing cancers are changed into more benign, less rapidly growing tumors. Experimental studies with tumor tissue show that as a result of heat or of radiation not strong enough to kill the tumor cells, the cells may lose the capacity for rapid growth and may become enclosed in a fibrous capsule.

The reactions of growth to radiation are: (1) Cell death without growth; (2) cessation of growth; (3) diminution of growth energy, followed by cessation of growth and by death; (4) diminution of growth energy, followed by recovery; (5) no effect; (6) stimulation.

A stimulating effect upon growth may be produced by sub-injurious doses of radiation. The stimulating dose, according to Seitz, is somewhat more than one-third of the destructive dose. The destructive dose for cancer cells apparently varies within wide limits. Seitz and his collaborators found it to be 100 to 110 per cent of an erythema dose of X-ray, but Wood and Prime find that it varies from two to eight times the erythema dose.

The action of radium on cancer cells is similar to the action of

X-ray, ultra-violet or even heat. These agents simply represent a non-specific interference with the life processes of the cells. Furthermore, the action of the various rays given off by a radio-active substance is believed by Loeb to be similar in character, differing only because of their relative intensity. Beta and gamma rays together are at least seven times more effective than gamma rays alone in killing tumor *in vitro;* 0.3 millimeter platinum absorbs 98.5 per cent of the primary beta rays. (Gamma rays are from ten to one hundred times as penetrating as beta rays.—Rutherford.) Repeated radiation induces a cellular immunity, consequently the first dose is the most effective one.

Greenough[4] states that radiation insufficient to cause a massive destruction results in inhibition of cell division lasting for longer or shorter periods, followed by a stimulated or abnormal growth. "If we are to cure cancer by radiation, cell destruction must be 100 per cent. This is feasible only when adequate drainage for necrotic tissue is provided."

Considerable evidence has been accumulated to show that, unless a massive destruction is desired, the most lasting results are obtained by long continued radiation of less intensity rather than brief radiation of greater intensity.[6,8]

Adenocarcinoma is more sensitive to radiation than is squamous cell carcinoma.[5]

How do these general considerations correspond with specific instances of the treatment of prostatic cancer by the use of radium? In the series of cases here presented, all of which were under the care of the writer, there were thirty-two radium treatments in twenty-nine patients. A summary of the results is shown in Table I. From Table II it will be seen that radium applied to the prostate by the insertion of seeds or of needles through the perineum, at least in the doses employed in this series (450 millicurie hours, 665 millicurie hours, 1,000 millicurie hours), did not check cancer growth to any appreciable degree. In two cases of total prostatectomy in which radium was applied to the seminal vesicles, the results were most unsatisfactory; in one case, the perineum never healed but continued to discharge slough until the patient died, three months after operation; in the other, a recto-urethral fistula developed one week after operation.

Nor was the implantation of radium into the shell of prostatic tissue which remained after a partial perineal prostatectomy much more satisfactory. There were eleven cases in which this was done,

TABLE I. RESULTS OF RADIUM TREATMENT

	No. cases	Dosage	
Applied through perineum without open operation.	3	1,000 mc. hrs. 665 mc. hrs. 450 mc. hrs.	Reobstructed—10 mos. Reobstructed—1 yr. Reobstructed—11 mos.
Total prostatectomy. Radium to vesicles.	2	756 mc. hrs. 1,200 mc. hrs.	Perineum never healed. Died 3 mos. Rectal fistula. Died 14 mos.
Partial prostatectomy. Radium applied to capsule.	11	2,248 mc. hrs. Average dose.	Operative deaths, 3. Died of cancer, 6. (Average, 14 mos. Longest, 2½ yrs.) Alive, 1. (4 months.) Untraced, 1.
Cystotomy. Radium implanted in prostate.	16	3,353 mc. hrs. Average dose.	Operative deaths, 3. Died of cancer, 7. (Average, 13 mos.) Died, cause unknown—4 yrs. Alive, 6. (2 at 3 mos.; 1 at 4 mos.; 1 at 13 mos.; 1 at 18 mos.; 1 at 4 yrs.)

the average dosage being 2,248 millicurie hours (Table III). In ten of these we used steel needles containing rather large amounts of radium emanation; in two cases, glass seeds of radon were also employed. In one case, platinum needles with walls 0.25 millimeters thick containing 5 milligrams of the element were inserted and left in for three days (2,880 milligram hours).

In these eleven cases there were three operative deaths, one six days after operation, probably from embolus, one nine weeks after operation from cardiac failure, and one thirty-three days after operation from sepsis (gangrene of scrotum). Six patients died of cancer, having lived on an average fourteen months after operation. The longest period was two and one-half years. One case was not traced; no report of the death of this patient could be found four years after operation. One patient is alive and doing fairly well four months after operation.

The largest group of cases is that in which the radium was implanted in the prostate through the open bladder (Table IV). There were sixteen of these. In eight, the median bar was excised; in one, the lateral lobes were enucleated; in two, a permanent suprapubic

TABLE II. PERINEAL APPLICATION—NO OPEN OPERATION

Name	Age	Date	Operation	Dosage	Result
1. Smith	58	Apr. 1930	Punch	Plat. needles 60 mc. —8⅓ hrs. for each lobe—1,000 mc. hrs.	Reobstructed—second operation 10 mos. later.
2. Mason	67	Nov. 1926	Partial Prostatectomy for Ca. 3 yrs. previous	10 gold seeds—0.5 mc. each—665 mc. hrs.	Little reaction. Second operation 1 yr. later.
3. Sinnott	65	May 1929	Punch	2 plat. needles into left lobe, 66-84 mc.—3 hrs.—450 mc. hrs.	11 mos. later reobstructed. Perineal prostatectomy. Left lobe broken down. Micr. showed adenocarcinoma.

TABLE III. PERINEAL PROSTATECTOMY PLUS RADIUM

Name	Age	Date	Operation	Dosage	Where applied	Result
1. Brown	73	Oct., 1924	Total	Steel needles, 756 mc. hrs.	Left vesicle	Perineum never healed. Died 3 mos. after operation.
2. Haskell	62	July, 1921	Partial	1 steel needle, 500 mc. hrs. 3 steel needles, 705 mc. hrs. 2 steel needles, 470 mc. hrs. (Total). 1,675	Right vesicle Right lobe Left lobe	Discharged 3 wks. Symptomatically well for 2 yrs. Died 2½ yrs. after operation.
3. Robinson	67	Sept., 1921	Partial	5 steel needles, 1,200 mc. hrs. 5 mg. each, 48 hrs.	Beneath trigone	Discharged 2 mos. post op. Paralysis from sp. Metastasis. Wound reopened. Died Dec. 11, 1921. Cancer.
4. Wendell	61	Feb., 1926	Total	2 plat. seeds, 5 mg. each—1,200 mc. hours—5 days.	Both vesicles	Developed rectal fistula 1 wk. after operation. Died April, 1927. Carcinomatosis.
5. Robbins	82	Jan., 1932	Prostatotomy	8 plat. needles, 5 mg. each—72 hrs. 2,880 mc. hrs.	Body of prostate	Discharged 7 wks. post op. Much pain requiring opiates to date (4 mos.). Control good.
6. Beausang	61	Dec., 1921	Partial	4 steel needles, 25 mc. each—24 hrs. 2,400 mc. hrs.	Prostate	Discharged 24 days after operation. Well for 1 year then had retention. Died Aug. 23, 1923 (1 yr. 8 mos.).
7. Carlton	58	July, 1919	Partial	3 glass seeds, 2,660	Prostate	Discharged 6 wks. post op.

7. Carlton	58	July, 1919 May, 1920	Partial	3 glass seeds, 2,660 mc. hrs. 48 mc. steel needles for 5 hrs., 240 mc. hrs.—2,900 mc. hrs. 470 mc. hrs.	Prostate	Discharged 6 wks. post op. March 1920—reobstructed. April 1921 general edema. Bladder emptying well. Date of death?
8. Coolidge	?	Aug., 1919	Partial	4 glass seeds, 6 mc. each—3,192 mc. hrs. 2 steel tubes, 14 mc. each—8 hrs., 224 mc. hrs.—3,416 mc. hrs.	Prostate	Died suddenly 6 days after operation. Probably embolus.
9. Johnson	76	Aug., 1921	Partial	7 steel needles, 66 mc., 33 hrs.—2,178 mc. hrs.	Prostate	Died 2 mos. after operation. Cardiac failure.
10. Stevens	68	Apr., 1921	Partial	5 needles Dose?	Prostate	Discharged 2 mos. after operation with perineal fistula. Died 7 mos. after operation. Cause?
11. Parker	60	May, 1931	Partial	6 steel tubes, 67 mc. Dose ? Hours ?	Prostate	Died 33 days after operation. Gangrene scrotum—edema left leg.
12. Shaw	70	Apr., 1921	Partial	5 steel tubes, 5 mc. each, 72 hrs.—1,800 mc. hrs.	Prostate	Discharged Apr. 24, 1921. Died May 24, 1921.
13. Howe	70	June, 1922	Partial	4 steel needles, 12.5 mc. each, 44 hrs.—2,200 mc. hrs.	Prostate	Untraced.

TABLE IV. CYSTOTOMY PLUS RADIUM

Name	Age	Date	Operation	Dosage and Result
1. Mason	68	Nov., 1927	Excision med. bar	10 gold seeds, each 2 mc.—2,660. (Died 17 days after operation, bronchopneumonia.)
2. Chapman	58	Dec. 1927	Aug., 1929. Punch. Specimen excised shows one focus of atypical cells, probably cancer.	19 gold seeds, each 2 mc—5,054. (4 yrs. after operation—X-rays show no metastases. Prostate small and hard. Bladder holds 2 ounces. Incontinent.)
3. Sinnott	66	Nov., 1930		21 gold seeds, each 2 mc.—5,544. (Discharged 7 wks. after operation. Incontinent. Sept., 1931, developed recto-urethral fistula. 1 yr. 5 mos. after operation, increasing induration in perineum and about prostate.)
4. Slattery	71	Aug., 1922	Excision med. bar	4 steel needles, 96 mc., 6 hrs.—576 mc. hrs. (Did well for 2 yrs., then began to fail. Prostate very large and hard. Bladder full of growth.)
5. Dunn	68	Dec., 1922		2 seeds, 1 mc. each—266 mc. hrs. 4 steel tubes, 108 mc.—11 hrs. 1,188 mc. hrs. 1,454 mc. hrs. (Could not empty bladder. Punch operation, 3 needles —1,672 mc. hrs. Jan. 11, 1923. Died Feb. 23, 1923.)
6. Sanborn	67	Jan., 1930	Permanent drainage	15 gold seeds, 1.3 mc. each—2,593. 4 plat. needles, 288 mc.—5¼ hrs. 1,512 4,105 (Died in hospital 4 mos. after operation. Autopsy—Pyelonephritis. Metastases to adjacent lymph nodes.)

7. Fairbairn	78	Dec., 1930	Permanent drainage Punch	20 gold seeds, 1 mc. each—2,660. (Died 11 mos. after operation. Carcinomatosis. Much urethral pain.)
8. Smith	59	Feb., 1931		20 gold seeds, 1.8 mc. each—4,752. (Died Aug. 10, 1931.)
9. Kempton	73	Jan., 1932	Excision med. bar	8 plat. needles, 5 mg. each, 96 hrs.—3,840. (Died 5 wks. after operation. Pulmonary embolus. Autopsy.)
10. McGaffigan	70	Jan., 1932	Excision med. bar	8 plat. needles, 5 mg. each, 48 hrs.—1,920. (Died 2 days after operation. Probably embolus.)
11. Whitaker	59	July, 1922		10 gold seeds, 1 mc. each—1,320. 4 steel needles, 12:5 mg. each—49¼ hrs. 2,462 3,782 (Died 4 yrs. after operation. Cause?)
12. McDonald	73	Dec., 1931	Excision med. bar	20 gold seeds, 1.5 mc. each—4,000. (Discharged 2 mos. after operation. Died 6 mos. after operation.)
13. Moulton	72	Feb., 1931	Excision med. bar	15 gold seeds, 2 mc. each—3,960. (Letter 13 mos. later says wound has reopened and patient passes considerable blood. General health good.)
14. Guenette	61	Jan., 1932	Excision med. bar	8 plat. needles, 5 mg. each, 96 hrs.—3,840. (Discharged 5 wks. after operation. 4 mos. after operation—prostate larger and firmer. Great bladder distress. Control good. No residuum.)
15. Stanley	74	Feb., 1932	Excision med. bar	10 plat. needles, 1 mg. each, 12 days—2,680.* (Discharged 6 wks. after operation. Voids frequently and with pain but has good control and no residuum.)
16. Hanson	74	Jan., 1932	Enucleation lateral lobes	15 gold seeds, 1.5 mc. each—2,825. (Discharged 6 wks. after operation. 3 mos. after operation patient voids frequently, every hour, no residuum. Has had a moderate amount of pain.)

*This patient died July 11, 1932. Autopsy showed extensive cancer of prostate, bladder and lymph nodes.

drain was left in. The average amount of radiation was 3,353 millicurie hours; the dosage varied from 1,454 millicurie hours to 5,544 millicurie hours. In ten cases, gold seeds with walls 0.2 millimeters thick, containing from 1 to 2 millicuries each, were used; in three cases, steel needles containing rather large amounts of emanation were used; in five cases, platinum needles containing 1 milligram or 5 milligrams of radium element were used.

In this group there were also three operative deaths: one from pulmonary embolus (clinical diagnosis) two days after operation, one from pulmonary embolus (autopsy) five weeks after operation, and one seventeen days after operation of broncho-pneumonia and myocarditis. Seven patients died within an average of thirteen months after operation, the longest period being four years; six of these were cancer deaths, but the cause of death in the man who lived four years is not known.

Of the six patients still alive, two were operated upon three months ago and one four months ago. All of these have good control and empty their bladders, but all have had severe strangury and great frequency of urination. In one case, particularly, the suffering has been extreme. The man operated upon thirteen months ago writes that his incision has reopened and he has passed a good deal of blood, but that his general health is good. The patient in the eighteen months case has been incontinent since operation; ten months after operation he developed a recto-urethral fistula; the induration about his bladder base and prostate has increased rapidly in the last two months. The man operated upon four years ago appears to be an arrested case; his prostate is very small and extremely hard, he shows no metastases by X-ray, his general health is fairly good. He is incontinent, however, and his bladder capacity is only 2 ounces. The bladder neck is fibrous and contracted. A punch operation was done one year and ten months after his radium treatment; the tissue excised showed one focus of atypical cells, probably carcinoma.

In the entire series, then, there were six operative deaths, a mortality of 21 per cent of the cases that were operated upon; three of these deaths were thought to be due to pulmonary embolus. Nine others died within one year. Four recent cases excepted, the only case in which the use of radium seems to have given the patient a better result than he would have had if nothing but relief

of obstruction had been attempted, is the patient who is alive after four years, but who is incontinent and very nearly obstructed by the development of scar tissue.

Unsatisfactory results following the use of radium in one form have led to the employment of this agent in other ways. Small amounts applied for long periods, large amounts for short periods and different varieties of screening have been tried. The implantation of gold seeds through the perineum was found to be unsatisfactory because, upon X-ray examination afterwards, the seeds were seen to lie in groups instead of being evenly distributed. In one case, following the implantation of gold seeds through the open bladder, a severe cystitis developed which lasted for months. Even with large doses (5,000 millicurie hours or more) the growth frequently recurred locally after one or two years, while in one case a recto-urethral fistula developed, and in another case the resulting fibrosis caused vesical neck obstruction and incontinence. In the hope that less necrosis would result, we tried inserting platinum needles into the prostate through the bladder. Four patients have been treated in this way. One died within two days, probably of embolus; another died in five weeks of pulmonary embolus originating in a thrombosed iliac vein. The latter patient suffered severely from frequency and strangury after his bladder incision had closed, and had severe spasms of the bladder even while he was on drainage. Another patient treated for four days with eight platinum needles with walls 0.25 millimeters thick, each containing 5 milligrams of radium (3,840 milligram hours), has suffered almost unbearable pain since his operation four months ago. The fourth patient was subjected to twelve days' radiation from ten one-milligram platinum needles with walls 0.5 millimeters thick (2,680 milligram hours). Although he had considerable pain and frequency lasting at least three months, the reaction was not so marked as in the preceding two cases. The total dosage was only two-thirds as great, for one thing, and the screening was 0.5 millimeters platinum instead of 0.25 millimeters. In comparing the cases treated by seeds with those given approximately the same amount of radiation by means of platinum needles, it is our impression that there is less pain and cystitis following the use of seeds. The results are not very different, however.

The suffering incident to radiation of the prostate might be ac-

cepted as part of the price which the patient must pay in order to control cancer, provided this end is really accomplished. The large percentage of cancer deaths occurring in our cases is not necessarily an indictment of radium treatment, for it may be that death was due to metastases already present. In three cases, however, we have definite microscopic evidence as to whether radium will destroy the cancer.

Case 1.—H. C., aged fifty-eight, in December, 1927, had nineteen gold seeds of 2 millicuries each implanted throughout his prostate through the open bladder. The growth appeared to be confined to the prostate and to a zone immediately surrounding the bladder neck. In August, 1929, twenty months later, a punch operation was done to relieve the resulting contracture. The tissue excised showed one focus of atypical calls, probably carcinoma.

Case 2.—J. S., aged sixty-seven, had had a partial perineal prostatectomy for carcinoma five months before his radium treatment. As hematuria, cystitis and partial obstruction developed, his bladder was opened and the prostate treated with radium. The bladder was found to be fairly normal. The outlet was patulous, the floor of the prostatic urethra covered with yellow slough. Anterior to the bladder neck was a crescentic plaque of new growth about three centimeters wide. The ureteral orifices appeared free of growth, but there was induration of the trigone. Ten gold seeds of 1.3 millicuries each were implanted in the crescentic area anterior to the urethra. Five other seeds were implanted in the trigone. Four platinum needles containing in all 286 millicuries of emanation were inserted into the prostate itself and left for five and one-quarter hours. The total dosage was 4,100 millicurie hours.

The patient lived four months after operation. The autopsy findings were as follows:

Anatomical Diagnoses: Carcinoma of prostate; bronchopneumonia: pyelonephritis (bilateral); pyo-ureter (bilateral); cystitis; suprapubic bladder fistula; healed apical tuberculosis (bilateral); arteriosclerosis.

Microscopical Diagnoses: Adenacarcinoma of prostate with extension to bladder; metastasis to lymph nodes; radiation necrosis of prostate and bladder; bronchopneumonia; pyelonephritis with abscess formation; cystitis; arteriosclerosis.

Clinical Examination—Prostate: A portion was removed. The remainder was indurated, markedly scarred and adherent to the floor of the bladder and rectum. Cut surface showed a nodular, firm, pale gray base. Where it was invading bladder it was a soft, sloughing necrotic mass about 6 cm. from side to side and about 5 cm. posteriorly, 3 cm.

deep. Scarring extended grossly to the outer borders on both sides. Some calcareous concretions were present.

Microscopic Examination—Prostate: There was marked fibrosis with foci of lymphocytes; dilatation of alveoli with foci of polymorphonuclear leukocytes in lumen with degeneration of epithelium, and

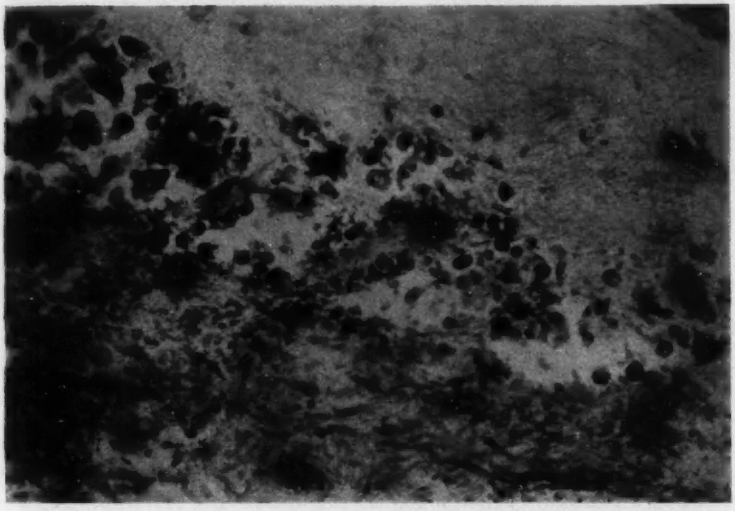

Fig. 1. Case 2. Photomicrograph from prostate of patient who died four months after radiation of 4,100 millicurie hours. This section shows dense fibrosis in the upper part and complete disintegration in the lower part. In the intervening zone are seen tumor cells.

slight perivascular infiltration. The second section showed marked fibrosis with necrosis and vessel reaction. The tumor showed scattered foci of tumor cells and necrosis with fibrosis. There was fibrous thickening of the vessel walls. The second section showed foci of necrosis of fibroblasts as well as of tumor cells. The third section (prostate) was similar. The fourth section was similar with marked vessel reaction. The fifth section was similar with marked hemosiderin deposition. The sixth section was similar with many small vessels occluded with widespread necrosis. The seventh and eighth sections were similar (Figs. 1 and 2.)

Case 3.—J. K., aged seventy-three, on January 19, 1932, had a suprapubic cystotomy for carcinoma of the prostate. The median bar

was excised with the diathermy knife, the tissue proving to be adenocarcinoma. Eight platinum needles, each containing 5 milligrams of radium, were inserted into the prostate about the bladder neck and left in for four days (3,840 milligram hours.) Three weeks after operation the patient had a pulmonary infarct (right lower lobe).

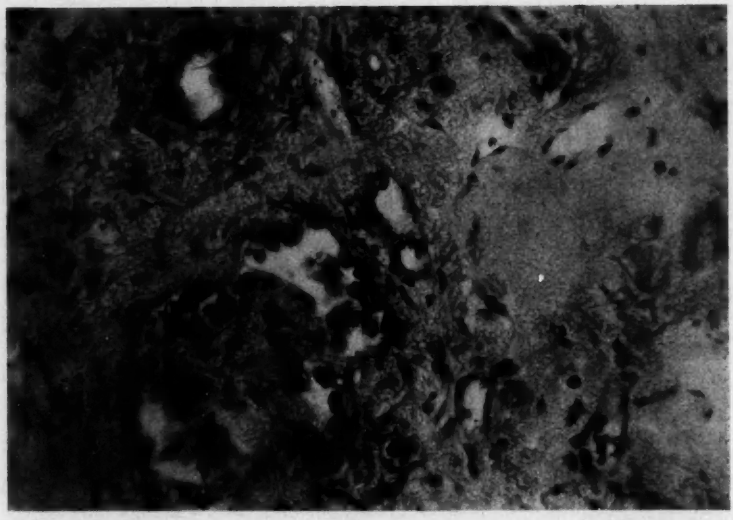

Fig. 2. Case 2. Another section showing considerable fibrosis on the right and in the upper left hand corner an artery with marked periarteritis. Tumor cells are visible in this section.

Two weeks later, as he seemed in fair condition, he was allowed out of bed. He had a pulmonary embolus and died in about ten minutes. The autopsy findings were as follows:

Anatomical Diagnoses: Carcinoma of prostate; radiation necrosis of prostate and bladder; metastases to para-iliac lymph nodes; pulmonary embolus; infarct of right lung, healing; generalized arteriosclerosis; thrombus, left common iliac vein; chronic cystitis; chronic pyelitis; acute splenic tumor; external vesical fistula; healed pericarditis with adhesions; healed pulmonary tuberculosis; right pleuritis with effusion; cutaneous neurofibromatosis.

Microscopic Diagnoses: Confirmation of the gross diagnoses and in addition: Adenocarcinoma of prostate; radiation reaction, rectum; organizing infarct of lung; chronic passive congestion of lung; healed appendicitis with obliteration of lumen.

Clinical Examination—Prostate: There was moderate symmetrical enlargement; abnormally hard in consistency. The middle lobe was necrotic down to the posterior commissure. Necrosis of dry type, focal in nature, suggested origin by radiation or cautery. The trigone also was involved in the necrotic process but not the lateral and pos-

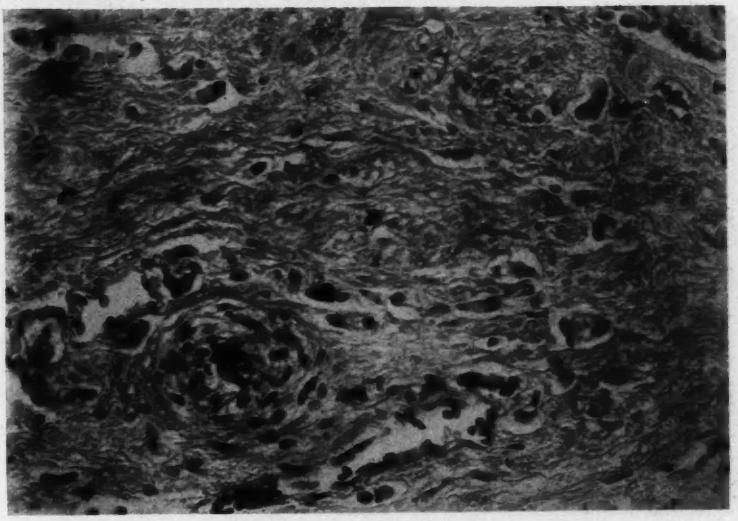

Fig. 3. Case 3. Photomicrograph from the prostate of patient who died five weeks after radiation of the prostate by platinum needles (3,840 millicurie hours). The section showed marked fibrosis with periarteritis. A few scattering tumor cells are seen.

terior lobes. Section through the prostate revealed a sharp cut edge, white granular texture, and absent capsule. Normal prostatic architecture was present in the anterior portion of both lateral lobes, but was not seen elsewhere. Genitalia were otherwise negative. The urethra was patent.

Microscopic Examination—Prostate: The site of the tumor consisted of numerous small clusters of rather poorly outlined, close-packed epithelial cells of uniform size in abundant dense fibrous stroma interspersed with poorly preserved smooth muscle fibers. Most masses were solid syncytia but some glands were present. Hyperchromia was rare. Mitoses were almost absent. There were no tumor giant cells and no necrosis. There was a marked tendency to invade the nerve trunks. No normal prostatic acini were found (Figs. 3 and 4).

These three cases prove definitely that radium applied to the prostate by seeds or needles, in amounts sufficient to give a total dosage of 3,840, 4,105 and 5,054 millicurie hours respectively, did not destroy all of the cancer cells. Extensive fibrosis was pro-

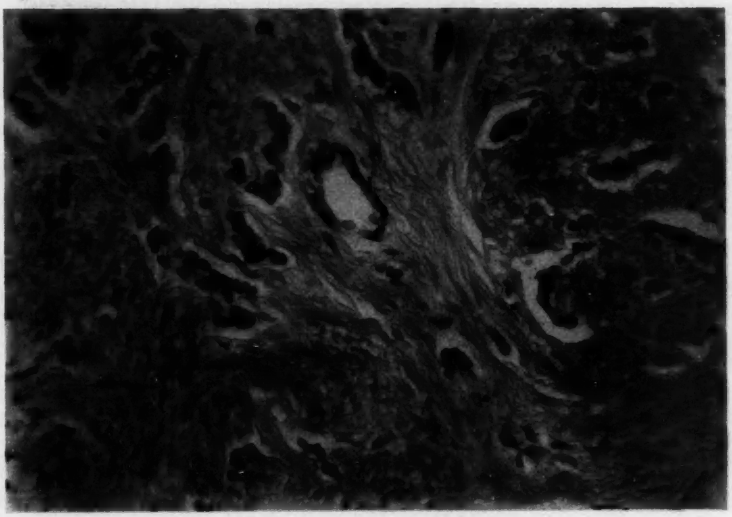

Figure 4. Case 3. Another section showing considerable fibrosis and numerous tumor cells, still apparently viable.

duced, which may have encapsulated the tumor cells and prevented their dissemination.

SUMMARY

Experiences with radium applications in twenty-nine patients showed the accuracy of Greenough's statement that cancer is not cured by anything short of a massive destructive dose. Necrotization of the entire prostate in this manner, or even its partial destruction, is accompanied by long continued, severe bladder spasms, contracted bladder and general toxemia. Radiation of less than a destructive dose has resulted in some cases in temporary regression of the tumor, followed by rapid growth of the cancer. In several patients living more than one and one-half years, fistulæ, incontinence and contracture of the bladder neck have resulted.

CONCLUSIONS

1. The effect of radium applied to the prostate in thirty-one operations in twenty-nine patients is summarized.
2. There were six operative deaths, three of which were due to pulmonary emboli.
3. Nine other patients died of cancer within one year.
4. The average length of life of those patients surviving operation who died of cancer was thirteen and one-half months.
5. Seven patients are still alive, four under one year, one at thirteen months, one at eighteen months, one at four years.
6. In three cases it was demonstrated that cancer cells had survived extensive radiation (3,800-5,000 millicurie hours).
7. Since it is not feasible to destroy the entire prostate by massive, destructive radiation, the object of radium treatment should be to employ a dose insufficient to cause extensive necrosis, with a view to causing fibrosis and a decrease in the malignancy of the tumor.

The writer wishes to express his thanks to Doctor Shields Warren, pathologist to the Deaconess and Huntington Memorial Hospitals, for making the photomicrographs presented with this paper.

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CARCINOMA OF THE PROSTATE

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One of the most vital problems confronting the urologic surgeon today concerns the early recognition of and therapeutic administration to cancer of the prostate.

Some authors have likened this lesion to a somewhat analogous one occurring in the female breast. In many points they are similar, in many others they are entirely different. Both are essentially a disease of the latter part of middle life. They are similar in their tendency to spread very early by the way of the lymphatic system. They are alike in their power to disseminate far and wide, and in their predilection to skeletal metastasis. The prognosis as to the duration of life in these two carcinomata is not good and the end-results of treatment are still unsatisfactory. Of the two, carcinoma of the prostate appears more unfavorable. Oertel[22] points out the similarity in the reaction of breast and prostatic tissues and contends that carcinoid hyperplasia in each of these organs is potentially cancerous, although they do not always develop into cancer. Cheattle[9] calls attention to a connected sequence of events occurring in the prostate similar to that which is observed in certain diseases of the breast. The cystiphorous desquamative epithelial hyperplasia transforms into epithelial neoplasia and this latter condition further changes into true cancerous tissue. In one section of a prostate the author observes all of the above three stages represented.

According to Mark and McCarthy,[21] the first case of carcinoma of the prostate was recognized by Langstaff in 1817. Billroth, in 1867, first attempted to treat this condition by surgery. The frequency of this neoplasm was not well recognized until 1900 when Albarran and Hallé intimated that it was not so very uncommon. Since then a number of studies have been made on this subject, various facts have been brought to light and many helpful suggestions presented by different investigators. In spite of the

numerous studies already made, the management of carcinoma of the prostate is still far from satisfactory. Another study on this subject is attempted with the hope of furnishing more data on this still unsolved problem. This study comprises 222 cases of prostatic carcinomata seen either in the Genito-Urinary Service of the Barnes Hospital or in private practice.

INCIDENCE

It is well recognized that cancer of the prostate is not at all uncommon. Hoffman[19] presents data of the New York Pathological Institute giving thirty-six deaths from carcinoma of the prostate in 2,641 deaths from cancer of various organs (908 male deaths and 1,733 female deaths). This make 1.3 deaths to every 100 deaths of all cancers of both sexes, or 3.96 deaths in 100 cancer deaths in males only. From the "Mortality Statistics"[7] of the Bureau of Census, it is noted that there were in 1927 a total of 1,141.9 deaths from all causes per 100,000 population in the registration area of Continental United States. Ninety-five and six-tenths deaths per 100,000 population were attributed to cancer and malignant tumors of all kinds, 3.5 of which were due to carcinoma of the prostate. This means that in about every one thousand deaths of both sexes in 1927 there were 3.5 deaths from carcinoma of the prostate, or in about every one thousand deaths of males of all ages, there were 5.6 deaths attributable to cancer of the prostate gland, and when it is considered in terms of the total deaths of almost 1,237,000 in the year 1927, its toll is far from insignificant. Furthermore, one should realize that the above figure represents only the number of cases definitely known, and that without any doubt there were many other cases of carcinoma of the prostate not included in the statistics on account of their diagnosis being not apparent, or else the secondary symptoms being so preponderant as to mask the true primary cause.

Young[20] gives a figure of 5 per cent of the total admission of his clinic as having carcinoma of the prostate. About 2 per cent of all genito-urinary cases seen by one of the writers (J. R. C.) in his private practice were cases of malignancy of this gland. Barney and Gilbert[1] state that 23.9 per cent of their 700 cases of obstructive conditions were due to malignancy. Cunningham[11] gives the statistics of carcinoma of the prostate as 20 per cent of all pros-

tatic obstruction. Of these 222 cases in this series, only 162 were admitted to the hospital, and this represents about 19 per cent of the total cases of prostatic obstruction treated in Barnes Hospital.

Correction of pre-cancer conditions, early recognition of cancer lesions and prompt therapy are fundamental. Since prostatic inflammation is so ubiquitous and inflammation is a precursor in many instances of cancer, it is quite possible that chronic prostatitis may be instrumental in the creation of a definite proportion of these cases. With this in view, it would seem quite necessary for the medical profession to devote stricter attention and supervision to the inflammatory lesions of the prostate. Our experience seems to indicate a definite association between the two lesions. It has been abundantly demonstrated that about one in every five cases of prostatism is due to cancer, and about 15 per cent of all men beyond fifty suffer from the results of prostatism. It is at least very suggestive that neglected inflammatory lesions may predispose to cancer growth. In hundreds of cases of chronic prostatitis which have been properly cared for we have seen cancer develop in but one or two instances. This is contrary to the usual conception of the pathologic anatomy of prostatic cancer, since it is supposed to start in the posterior lobe or surgical capsule well away from the site of the usual inflammatory or hyperplastic changes in this gland. Another significant feature which indicates that many prostatic cancers do not originate in the posterior capsule is that the tissue removed from the internal orifice of the bladder by means of the punch clearly exhibits the cancer lesion in 80 per cent of the cases, even in many instances in which palpable evidences through rectal examination either disclosed an early lesion or a questionable malignancy.

METASTATIC CARCINOMA OF THE PROSTATE

There are four cases in this series of 222 cases of carcinoma of the prostate, the primary lesion of which is being questioned. Three patients came into the hospital with the chief complaint referable to the gastro-intestinal tract and did not have any symptoms suggestive of the genito-urinary system at all. Physical examination resulted in the diagnosis of carcinoma of the stomach with carcinoma of the prostate. All three patients died in the

hospital, but autopsy was obtained in only one case. In this case necropsy showed that carcinoma of the stomach was the primary lesion and the growth in the prostate was proved to be metastatic. In the other two cases the growths were visualized through the laparotomy wound. They were definitely carcinoma of the stomach with extensive metastases to the abdominal viscera. There was probably metastasis to the prostate also. While it is possible that the carcinoma of the prostate in these last two cases may have been an independent growth happening by chance to co-exist with a similar growth in the stomach, yet it seems that this is less probable than that the lesion was metastatic. These reports issue from the general pathologic laboratory where unquestionably there is entire familiarity with the usual tendency of the prostate to be primary and to metastasize to the abdominal cavity. The distant metastases of gastro-intestinal tract carcinoma, commonly known as Krukenberg's tumor, is occasionally seen, especially in the female. Hermann[17] observes one case of metastatic carcinoma of the urinary bladder in ten cases of Krukenberg's tumor in males, but no mention is made in regard to the metastasis to the prostate gland. These three cases (1.5 per cent) represent secondary carcinoma of the prostate originating from the primary growth in the stomach. In the fourth case, the prostatic lesion of which was not definitely established as being primary, we have the following report:

Case 4.—Clinical diagnosis was carcinoma of the prostate with extension to bladder; chronic cystitis; stricture urethra metastatic; myocarditis.

Autopsy findings included the following: The bladder was large and contained a large amount of reddish purulent foul smelling material. The prostate separated from the symphysis with difficulty and when removed presented a ragged necrotic mass. This whole area as well as a large portion of the bladder about the neck was infiltrated with a firm white mass of tissue. A probe passed through the posterior urethra and into the bladder with some difficulty. It could not be made out whether there was any destruction distal to the posterior urethra. The bladder mucosa was dirty and covered with a necrotic purulent gray exudate. The rectum separated from the posterior part of the bladder with difficulty.

Microscopic section near the dome of the bladder showed islands of tumor cells still in the mucosa and submucosa. In section about the trigone the tumor cells had already extensively infiltrated the

muscularis layer. In places the islands of tumor cells had somewhat a papillomatous arrangement with a basement membrane of connective tissue.

The heart weighed 310 grams. Myocardium of the left ventricle averaged 20 mm. in thickness, and was infiltrated with a number of nodules of firm white tissue with a faint yellow tint. Some of these encroached upon the myocardium of the left ventricle, so that they projected as elevated irregular masses into the ventricular cavity. Valves were all normal. Coronary vessels appeared to be normal.

Microscopic section showed muscle infiltrated with frequent islands of tumor cells. These cells were large and contained large dark nuclei. Mitotic figures were frequently observed. The arrangement was that of the squamous epithelium of bladder mucosa.

Suprarenals were rather small but normal in appearance.

Microscopic section contained a small area of tumor islands, the cells lying on a basement membrane as those seen in section of the heart. Nuclei were hyperchromatic, and the intercellular bridges could not be made out although the cells had the appearance of squamous cell epithelium.

Anatomic diagnosis was primary carcinoma of the bladder with extension to the prostate.

There were metastases to the myocardium and suprarenal.

Ewing[13] in his text-book, "Neoplastic Diseases," divides carcinoma of the prostate into two groups, the "adenocarcinoma" and "carcinoma," and he further distinguishes two subclasses under the latter as "scirrhous carcinoma" and "squamous epithelioma." The microscopic sections of the above case give the picture of squamous epithelial tumor with cellular arrangement similar to that of the bladder mucosa. It may be that this is a carcinoma of the prostate gland of the squamous epithelioma type as classified by Ewing. It has been shown by Aschoff and Schlachta[18] that in the upper portion of the fetal prostate, the ducts are lined by squamous epithelium up to the third month of life or later. Schmidts observed extensive epithelial metaplasia in chronic suppurative prostatitis. Thus would it not be possible that the remnant of this squamous epithelial tissue of the prostate might become the primary seat of the new growth? It might later extend directly to the bladder neck. The metastatic lesions would thus naturally be of squamous cell type. But as the primary lesion in this case is questionable, it seems wise to eliminate it from the study below. The three cases of secondary carcinoma of prostate metastasizing from the primary site in the stomach are not included in the following study either.

TABLE I. MICROSCOPIC DIAGNOSIS OF THE TISSUE REMOVED

No. cases	Method of removal	Diagnosis	
		Positive	Negative
64	Tissue removed by Caulk's cautery punch	52 (81.4%)	12
43	Tissue removed by prostatectomy	42 (97.6%)	1
107		94	13

DIAGNOSIS OF THE CASES

The diagnosis of carcinoma of the prostate in this series was made largely through the process of exclusion supported by the characteristic feel of the carcinomatous glands per rectum. The final diagnosis of all cases in this series was made by one of the senior members of the service. Microscopic examination of tissues removed was made in 107 cases. The prostatic tissue was obtained by the punch operation in sixty-four cases and by prostatectomy in the other forty-three cases (Table I). None of the tissue in this series was taken by the needle of Barringer. Of these 107 cases, report of microscopic diagnosis came back positive for carcinoma in ninety-four cases; fifty-two, or 81.4 per cent, were obtained by the punch. It is of interest to note that about 80 per cent of tissue removed by punch histologically proved to be carcinoma. This fact does not very well fit in with the assumption that carcinoma of the prostate commonly starts in the posterior capsule. If such were the case, it must be assumed that the growth has practically involved the whole gland before the cancerous tissue could be punched out per urethra. It is well recognized that a minute growth of the prostate readily escapes detection.[4, 18] Thus a negative report on tissue examined does not disprove the presence of a carcinoma in the gland. In this series it was noted that in two cases suspicious of carcinoma of prostate prostatectomy was done and the glands were examined microscopically with the diagnosis of benign hypertrophy. A little over a year later, the patients returned with typical carcinomatous masses at the site of the prostate with metastatic lesions in bladder in both cases. Hunt[20] observes one similar case. It is commonly understood that simple prostatectomy does not completely remove the prostatic tissue, hence it is very likely that a part or perhaps even the whole cancerous growth in the prostatic tissue was left behind in the above cases. These cases

would seem to support the fact that certain lesions are confined to the posterior capsule.

TABLE II. AGE INCIDENCE IN 196 CASES OF CARCINOMA OF THE PROSTATE

Age by decades	No. cases	Per cent
20–29 years	1	0.5
30–39 years	1	0.5
40–49 years	10	5.1
50–59 years	37	18.9
60–69 years	75	38.3
70–79 years	60	30.6
80–89 years	12	6.1
Total number of cases	196	100.0

Mean average age of 196 cases..... 63.4 years
Youngest case in the series..... 25 years
Oldest case in the series..... 85 years

AGE INCIDENCE

Carcinoma of the prostate is essentially a disease of late middle age. Table II gives the distribution of 196 cases in this series under the various decades of life. It will readily be seen that 93.9 per cent of the cases were above fifty years of age and approximately 90 per cent were between the sixth and the eighth decades of life. The average age of all cases when first seen was sixty-three years. In Bumpus' series the average age was sixty-four and eight-tenths years. In 129 cases of Barringer[2] 122 patients, or 94.6 per cent, were above fifty years of age. Only two of his patients were between thirty and forty years of age. The youngest case in this series was a patient twenty-five years old admitted to the house complaining of pain in the rectum of six months' standing. Examination revealed carcinoma of the prostate. The patient died nine days after admission and postmortem examination revealed carcinoma of the prostate with metastasis to the liver, peritoneum, retroperitoneal glands and mediastinal glands. The youngest case of carcinoma of the prostate reported in the literature is that in a youth of seventeen reported by Gardner and Cummins.[15]

SYMPTOMS

Cancer of the prostate in itself produces no symptom, but on account of its proximity to the bladder neck, its change in size will

readily give rise to urinary disturbances. Bumpus[5] reports that in seventy-nine cases of carcinoma of the prostate with metastasis, pain occurred as the first symptom in 34.1 per cent, frequent urination in 27.8 per cent and difficulty of urination as the initial symptoms in 16.4 per cent while in the group of 283 cases without metastasis, the first symptoms are given as frequency in 36.7 per cent, difficulty in 32.5 per cent and pain in only 12.01 per cent. Increased frequency of micturition and difficulty in urination are the two most common symptoms given by the patients in Bumpus' series. Barringer[2] reports that 115 patients out of his series of 145 cases, presented urinary disturbances as the early symptoms. Barney and Gilbert state that over 22 per cent of their patients had chief complaints not referable to the genito-urinary system. Bugbee contends that "the sudden onset of retention in the presence of comparatively mild urinary symptoms may be suggestive of malignancy." The chief complaint of 194 cases in this series is tabulated in Table III. It will be noted that 143 patients out of

TABLE III. THE CHIEF COMPLAINT AS GIVEN BY THE PATIENTS AT THE TIME WHEN THEY WERE FIRST SEEN WITH THE AVERAGE DURATION OF THE COMPLAINT

1. COMPLAINT REFERABLE TO THE URINARY SYSTEM—143 cases (73.71 per cent)		
	No. of cases	Average duration of the complaint
Obstruction to urination (ranging from slight difficulty to retention)	61 (42.6%)	3 years 2 months
Frequency in urination	51 (35.6%)	2 years 11 months
"Bladder trouble"	16 (11.2%)	3 years 8 months
Painful urination	7 (4.9%)	3 years 1 month
Nocturia	6 (4.3%)	1 year 10 months
Hematuria	1	
Dribbling	1	
Total	143 cases (100.0%) with mean average duration of complaint of urinary symptoms of 3 years.	

2. COMPLAINT SUGGESTIVE OF EXTENSION OR METASTASIS—42 cases (21.65 per cent)	
Low back pain	14
Pain in the legs	10
Weakness and loss of weight	8
Pain in the rectum	4
Gastro-intestinal symptoms	4
Edema of the lower extremities	2
Total	42

COMPLAINT OTHER THAN UNDER GROUP 1 AND 2—9 cases (4.64 per cent)

194 cases or about 70 per cent complained of symptoms referable to the genito-urinary system with a mean average of three years' standing. Symptoms of obstruction, ranging from some difficulty in voiding the urine to a complete urinary retention, and frequency of urination were the two most common complaints made by patients when they were seen for the first time. Forty-two patients, or 21.65 per cent of the total number in this series, presented, as their complaints, symptoms not referable to the urinary system but very suggestive of extension of the growth or metastatic processes. Among these complaints, pain in the lower back and in the legs appears to be the most common one. Nine patients were admitted with complaints other than those recorded above and in these cases the carcinoma of the prostate was found accidentally. One of these nine patients was admitted to the hospital as an accident case and examination revealed carcinoma of the prostate with extensive skeletal metastasis. In another patient admitted to the medical service for leukemia, routine physical examination brought out an independent cancer of the prostate and the necropsy report of this case confirmed the clinical diagnosis. In one case, carcinoma of

TABLE IV. THE FIRST SYMPTOM OF THE PRESENT COMPLAINT AS NOTED BY THE PATIENTS IN 194 CASES

1. FIRST SYMPTOM REFERABLE TO THE URINARY SYSTEM	No. of cases
Frequent urination	57
Difficulty in urination	42
Painful urination	20
Nocturia	22
Hematuria	5
Retention of urine	4
Dribbling after micturition	3
Urgency	2
Weak stream	3
Desire to urinate all the time	1
Incontinence	1
Total	160 (82.48%)
2. FIRST SYMPTOM SUGGESTIVE OF SPREAD OF MALIGNANCY	**No. of cases**
Low back pain	7
Gastro-intestinal symptoms	7
Weakness and loss of weight	5
Pain referable to hip joint	5
Pain in the legs	2
Total	26 (13.4%)
3. FIRST SYMPTOM OTHER THAN THOSE OF GROUP 1 AND 2	8 cases (4.12%)

the prostate was found co-existing with an independent tumor of the brain. The diagnosis of this last case was confirmed by post-mortem examination. These silent cases comprise 4.64 per cent of the total cases in the series.

The symptoms of onset are listed in Table IV. The two common earliest symptoms noted by the patients in this series were frequency and difficulty of urination. One of the silent cases in Table III gave a history of having frequent urination several years

TABLE V. GENERAL SYMPTOMS OF THE PRESENT COMPLAINT OBTAINED IN 194 CASES IN THIS SERIES

	Number of cases	Frequency of occurrence
Frequency of urination	122	1 in 1.6
Painful urination	100	1 in 1.9
Difficulty in urination	94	1 in 2.1
Retention of urine	70	1 in 2.8
Urgency	50	1 in 3.9
Hematuria	39	1 in 5.0
Dribbling after micturition	41	1 in 4.8
Nocturia without increase in frequency during day	41	1 in 4.8
Weak stream	16	1 in 12.2
Difficulty in starting stream	12	1 in 16.2
Pain referred to low back	39	1 in 5.0
Pain referred to legs	32	1 in 6.1
Pain referred to hip joint	14	1 in 14.0
Loss of weight	70	1 in 2.8

prior to the date of admission. Table V tabulates the general symptoms of all cases, and here it is to be noted that frequent, painful and difficult urination are the three most common general symptoms in the series. It is commonly recognized that low backache and sciatica-like pain are fairly common in patients with carcinoma of the prostate. In this present study, it is observed that low back pain was encountered once in every five cases while the sciatica-like pain was encountered once in every six and one-tenth cases of carcinoma of the prostate.

BLOOD PICTURE OF THE CASES

Piney[23] in his paper on "Carcinoma of the Bone Marrow" points out that metastatic lesions in the bone marrow frequently give rise to "pernicious anemia"-like changes in the blood. He further summarizes the changes which he believes to be sufficiently char-

acteristic for the diagnosis of carcinosis of the bone marrow as follows: (1) Reduction in the number of red corpuscles; (2) high color index, not always above one; (3) slight leukocytosis; (4) leukocytosis due to increase of polymorphonuclear neutrophils; (5) anisocytosis, et cetera, well marked; (6) nucleated red corpuscles present, both normoblasts and megaloblasts; (7) myelocytes and myeloblasts present.

In almost every case of cancer a definite degree of anemia is present but this is not of a specific character. Roberts[24] divides carcinoma of the prostate into three groups: (1) Cases in which prostatic symptoms predominate; (2) cases in which pelvic and sacral pain predominate, and (3) cases in which distant dissemination of the growth gives rise to symptoms. In Class 3 Roberts recognizes profound anemia almost of the pernicious anemia type as one of the clinical features. In 156 cases of this series blood counts were obtained. The findings of the blood examination

TABLE VI. RELATION OF THE BLOOD CHANGES TO THE SKELETAL METASTASIS IN 156 CASES OF CARCINOMA OF THE PROSTATE

	With skeletal metastasis	With other metastasis than bone	Metastatic lesions not found
Number of cases	32	56	68
Average hemoglobin percentage	70	95	
Average red cell count	3,550,000	4,350,000	
Average color index	0.98	1.10	
Average white cell count	8,200	11,700	
Blood picture in patients free from symptom of hematuria			
Number of cases	23	44	
Average hemoglobin percentage	65	100	
Average red cell count	3,310,000	4,360,000	
Average color index	9.98	1.15	
Average white cell count	8,100	11,800	

are tabulated in Table VI under two groups, one with skeletal metastasis and the other with metastasis to other than the osseous system. Under the former group, it is observed that the average red cell count and the mean percentage of hemoglobin of the blood are distinctly lower than in the latter. The reduction of the number of red blood cells and of the hemoglobin percentage could not be accounted for by visible hemorrhage, for, even eliminating the

cases with hematuria as one of their symptoms, the figures remain low. Eight cases under this group with skeletal metastasis show the most marked anemia with an average of two and nine-tenths million of red blood cells per cubic millimeter and 50 per cent hemoglobin. It is to be regretted that the data of the cases are not sufficient to permit one to study the other characters of the blood changes also. The figures for the group with metastases elsewhere than in the bones are within the normal variation.

BLOOD PRESSURE READINGS OF THE CASES

Blood pressure readings were recorded in 125 cases of this series of carcinoma of the prostate. Using Faught's[14] method, the normal blood pressure variation for the different ages was computed. Comparing the normal computed value for the age, with the actual reading of the case, it is found that 26.4 per cent of these 125 cases available for study showed definitely high blood pressure and 20.0 per cent of the cases gave readings below the normal variation. Shaw and Young[26] believe that prostatic hypertrophy does not cause any marked increase in the blood pressure and support their contention by figures showing that blood pressure bears no relation to the residual urine of the case. Under

TABLE VII. RELATION OF BLOOD PRESSURE TO THE URINARY DISTURBANCES IN 125 CASES OF THIS SERIES

	Total No. of cases	B.P. reading within normal variation. No. cases	B.P. reading higher than normal variation. No. cases	B.P. reading lower than normal variation. No. cases
All cases regardless of their complaints	125	67 (53.6%)	33 (26.4%)	25 (20.0%)
Cases with urinary symptoms as their chief complaints	90	49 (54.4%)	30 (33.3%)	11 (12.3%)
Cases with N. P. N. higher than 50 mgm. per 100 c.c. of blood	21	12 (57.1%)	7 (33.3%)	2 (9.6%)

Table VII cases with the chief complaint referable to urinary disturbances and cases with high non-protein nitrogen in the blood are grouped according to their blood pressure readings. The percentages under the column of high blood pressure reading show a slight rise in cases with urinary disturbances and also in cases with

high non-protein nitrogen contents in the blood. The increase is not striking as one would expect if the dysfunction of the genito-urinary apparatus was responsible for the increase in the blood pressure. Thus from the results of this study, it would seem that urinary disturbances tend slightly to cause increase in blood pressure, but one is not justified in positively concluding that the disturbance of the urinary passage is responsible for the hypertension, for the increase in percentage here is within the limit of error, the total number of cases being comparatively small.

THE SIZE OF THE PROSTATE

The size of the prostate was recorded in 205 cases. Thirty-four per cent were small, 48 per cent moderate and only 18 per cent large. Fifty per cent of the prostates which metastasized were small, 25 per cent were of moderate size and 25 per cent large. Bone metastases occurred in 19 per cent. The majority of the bone metastases were associated with the small or moderately enlarged prostates. Eighty per cent of the bone metastases were located in the pelvis and lumbar spine, 10 per cent in the femur, 5 per cent in the ribs, and 5 per cent in the shoulder. There were seven cases showing direct extension: three to the bladder, one to the rectum, one to the bladder and rectum, and two to the urethra. It is generally known that carcinoma of the prostate is of two types, one with a strong tendency to produce early and distant metastasis while the other with a longer course is commonly associated with marked urinary disturbances. The prostate gland in this latter type of carcinoma is very frequently found to be enlarged, while in the former type the gland is usually of normal size or smaller than normal.

CYSTOSCOPIC FINDINGS

It is the experience of the Genito-Urinary Service of the Barnes Hospital that the cystoscopic finding of irregularity at the internal orifice is of special importance in carcinoma of the prostate. The intravesical obstruction in cancer of the prostate is usually not as pronouncedly lobular as in benign affairs, but tends to assume a collar arrangement or contracture and is likely to show irregularities, cystic and bullous changes and occasionally deposits of fibrin and submucous hemorrhage. An irregular edematous appearance is suggestive of carcinoma.

Another important feature often noted by the Service is puckering of the bladder mucosa at the sites where the seminal vesicles are in contact with the bladder wall. Submucous hemorrhages may be observed at the depression and in later cases small areas of ulceration. This is designated as "neighborhood carcinoma."

In 105 cases of this series the cystoscopic findings are available

TABLE VIII. THE CYSTOSCOPIC FINDINGS IN 105 CASES

	Number of cases	Frequency of occurrence
General collar enlargement of the prostate gland with or without irregularities	50	1 in 2.1
Trabeculation of bladder mucosa	46	1 in 2.3
Median lobe enlargement	36	1 in 2.9
One or both lateral lobes enlarged	22	1 in 4.8
Tumor in bladder	17	1 in 6.2
Diverticulum in bladder	13	1 in 8.1
Stone in bladder	8	1 in 13.0

and they are tabulated in Table VIII. About one-half of the cases show some amount of trabeculation or corrugation of the bladder mucosa. This finding is not of special interest in carcinoma of the prostate, as it is commonly seen in cases of urinary obstruction. Dossot[12] makes mention of the fact that the bladder in cases of carcinoma of the prostate is most frequently increased in volume and its internal surface is trabeculated with more or less distinct cellules, an appearance which he believes is definite especially in adenoid cancer. Other findings of the cystoscopic examination are that of the prostatic hypertrophy which are not of special interest to this subject.

METASTASIS

Geraghty[16] states that twenty-one out of 400 cases of carcinoma of the prostate had the process confined to the prostate alone. Barney and Gilbert[1] place the percentage of metastases in their series of carcinoma of the prostate as 58 per cent. In Bumpus' series[6] 28 per cent of the patients already had metastasis to bone at the time when they were first seen. In 98 per cent of Barringer's cases[3] the carcinomatous growth had already grown beyond the prostate when he first saw them. Out of 197 cases in this series 101 cases, or 51.3 per cent, presented demonstrable lesions beyond

the prostatic gland, and in eighty cases, or 40.6 per cent, the process had extended beyond the prostate and the seminal vesicles.

TABLE IX. THE EXTENSION AND DISTRIBUTION OF THE METASTASIS OF THE CARCINOMA OF THE PROSTATE IN THIS STUDY

197 cases of primary carcinoma of the prostate in this series.
103 cases (52.2%) with malignant process extended beyond the prostate.
80 cases (40.6%) with malignant process extended beyond the prostate and seminal vesicles.
36 cases with metastatic lesion.

DIRECT EXTENSION OF THE GROWTH TO	
Seminal vesicles	39
Bladder	21
Rectum	4
Urethra and perineum	1
Ureter and kidney	1

METASTATIC LESIONS

Lymphatic System	Number cases	Frequency of occurrence with skeletal metastasis
Inguinal lymph nodes	13	
Retroperitoneal nodes	10	
Mediastinal lymph nodes	4	
Substernal lymph nodes	1	
Supraclavicular lymph nodes	1	
Cervical lymph nodes	1	
Axillary lymph nodes	1	
Lungs	8	
Liver	7	
Peritoneum	4	
Large intestine	3	
Kidney	2	
Pleura	2	
Myocardium	1	
Abdominal wall (cystostomy wound)	1	
Brain	1	
Bones		
Pelvis	22	1 in 1.6
Vertebræ	19	1 in 1.9
Femur	6	1 in 6.0
Ribs	8	1 in 6.0
Shoulder girdle	4	1 in 9.0
Skull	3	
Humerus	2	
Mandible	1	
Patella	1	

The distribution of the metastases in this series is given in Table IX. There were only fifteen cases autopsied and only five cases were found with metastases, the findings of which are to be found in Table X. The skeletal metastatic lesions and the secondary growth in the lungs were revealed by the X-ray. While the extension of the carcinomatous process to the seminal vesicles and to the rectum was diagnosed by digital palpation, the diagnosis of the location of other metastatic lesions was reached after the usual physical examination. In some cases the abdominal metastatic lesions were visualized through operative wounds. The extension of the carcinomatous process via the seminal vesicle appears to predominate with the spread to the pelvic bones ranking next. Barringer[2] and Young[30] believe that the commonest extension of carcinoma of the prostate is toward the seminal vesicles and the next common line of extension is laterally from either prostato-vesicular junctions to each ramus of the pubic bone. The findings in this series are en-

TABLE X. NECROPSY OF THE CASES IN THIS SERIES OF 201 CARCINOMA OF THE PROSTATE

Total number of cases autopsied	17
Primary carcinoma of the prostate	15
Metastatic carcinoma of prostate	2

Primary carcinoma of the prostate	Number cases
No sign of metastasis	10
With metastasis distributed as follows:	5
Retroperitoneal nodes	3
Mediastinal nodes	3
Bladder	2
Peritoneum	2
Pleura	2
Perineum and urethra	1
Axillary lymph nodes	1
Ureter and kidney	1
Kidney	1
Inguinal lymph node	1
Myocardium	1
Liver	1
Pelvis, ribs and vertebræ	1
Metastatic carcinoma of the prostate	
Primary carcinoma of the stomach with general metastasis including the prostatic gland	1
Primary carcinoma of bladder with extension to the prostate and metastasis to adrenal and myocardium	1

tirely in accordance with the contention of Barringer and Young. One would expect to find the extension of the growth to the seminal vesicles more frequent than once in about five cases in this series. It is to be noted, however, that early carcinomatous lesions of the vesicles are very easily missed by the palpating finger. Dossot[12] also is of the opinion that carcinoma of the prostate frequently extends toward the seminal vesicles, and further believes that invasion of the neoplastic tissue to the bladder is quite frequent. Among his 89.4 per cent of cases with adenopathy, Dossot observes only three cases with involvement of inguinal lmyph nodes. Bumpus' series[5] shows that 46.1 per cent of the patients had glandular metastases with inguinal lymph nodes heading the list. In this series inguinal node metastasis also heads the list of glandular involvement. This is readily explained by the fact that inguinal lymph nodes are superficially situated, hence easily accessible to the palpating finger, while in early involvement of the iliac and retroperitoneal glands they are in most cases not palpable. Fifty-one per cent of Bumpus' cases[5] had secondary growth in bones, with the pelvic bones as the most frequent site. Young[30] states that prostatic carcinoma commonly metastasizes to the pelvis and vertebræ. Ewing[18] ranks carcinoma of the prostate as first in metastasis to the osseous system. Kaufmann calculated that about 70 per cent of prostatic carcinomata cause skeletal metastases, as compared with 37 per cent for thyroid carcinomata (Limacher) and 14 per cent for mammary carcinomata. In this series only 19 per cent are known to have skeletal lesions. This relatively small number of patients with metastasis to the bones is due to the fact that only a few and generally only those that were strongly suspicious of bone metastasis were sent for X-ray picture. Thus it would not be fair to convert this figure into percentage in relation to either the total number of cases or to the number of cases having X-ray of the skeleton, for the percentage will be too low in the former and too high in the latter than the actual rate. It will be noted in Table IX that the pelvic bones are the sites of metastases once in every one and six-tenths cases, and that the vertebræ once in every one and nine-tenths cases of carcinoma of prostate with skeletal metastasis.

The tendency of carcinoma of the prostate to distant dissemination is well recognized. Charteris[8] reports a case of this type of

tumor of the prostate with metastasis to skull and other bones, and yet postmortem examination revealed only slight enlargement of the glands along the iliac vessels while the abdominal visceræ completely escaped the invasion of the malignant tissues. The author could not reconcile these findings to metastasis by way of the lymphatic stream. According to him, the facts are more in accordance with blood stream dissemination. Piney[23] is also of the belief that metastasis to the bones arising from the primary growth in the prostate is brought about by the blood stream and further demonstrates that there is no evidence of lymphatic channels in the bones. Roberts,[24] however, maintains that it is not decided that the blood stream plays any important rôle in the spread of the cancer cells from the prostate. He explains the metastasis to the lower extremities by way of the lymphatic plexus surrounding the blood vessels to the bones, and he further suggests another route of spread through the lymphatic vessels and tissue spaces of the spinal laminæ with their associated ligaments by which the malignant cells may travel to reach vertebræ, ribs, skull and other bones. This will thus explain the non-involvement of the lymphatic system in the abdomen in cases with metastasis to skull and bones of upper extremities. Roberts reports three cases with lesions in the spinal laminæ with their ligaments to corroborate his suggestion. At present the weight of evidence, such as the findings of the iliac lymphatic enlargement in autopsied cases, seems to suggest that the malignant cells commonly pass from the primary site via the lymphatic system. This fact is of value in the early treatment of patients.

It may further be noted that one of the patients in this series had metastasis to the myocardium, which is a comparatively rare site for secondary growth. In another one of the cases the patient had brain metastasis with symptoms of paralysis of the glossopharyngeal and hypoglossal nerves. This patient also had metastatic lesions in the spine.

Extensions from the prostate to surrounding parts—urethra, bladder and rectum—occur as late manifestations and are far less frequent than metastatic changes. Only a few of our cases showed urethral extension. Bladder invasion, except the usual obstructive conditions at the orifice, occurs usually from implication through the seminal vesicles. The rectum is protected by Denon-

villier's fascia and is involved as a part of an invasive process. It, like the bladder, derives its lesions more commonly from the seminal vesicles. It is usually for the relief of pain in the back, along the sciatic or during the act of urination, that such patients consult the doctor and then the disease has extended, in many cases, too far for repair. Many observers are deceived into thinking that an apparently cachetic patient is beyond relief, when, as a matter of fact, the condition is occasioned by uremia and toxemia, the results of obstruction, and if the obstruction be removed by proper treatment tremendous help will be afforded and such patients, although suffering from cancer, may enjoy additional years of comfortable living. No such cases should be considered as hopeless but in every instance the obstruction should be relieved and then there is an opportunity to determine the comparative effects of the uremia and toxemia from the obstruction and the devastation of cancer.

TREATMENT

The results of the different treatments reported in the literature vary considerably. No attempt is made to review them all. In some hands the radical prostatectomy of Young proves successful. Of the twenty-six cases of total prostatectomy reported by Smith,[27] three died in the hospital, eight died since leaving the hospital, having lived an average of twenty-two months after operation, and fifteen are still living at varying periods up to six years after operation. Barney and Gilbert[1] conclude from their study that surgery alone is better than radium alone, but the combination of the two is often advantageous. Chute[10] advises simple prostatectomy in all instances where the malignant process produces obstruction to urination but believes, however, that radium should be used in conjunction with surgery. Bumpus[6] reports that the results of radium treatment of cancer of the prostate in his series are inferior to those obtained by surgery, but he is also of the belief that the combination of surgery and radium offers the best result. Barringer[2] on the other hand states that his results show the superiority of radium treatment over the operative treatment both in causing the regression of the growth and in coping with the urinary symptoms. Geraghty[16] stated that in 95 per cent of cases surgery alone is hopeless in the treatment of the carcinoma of the prostate and was

of the opinion that radium had a definite field of usefulness. Smith and Pierson[29] advocate X-ray treatment for cases not suited for surgical removal.

The treatment of the patients in this series varied a great deal at different times and also varied somewhat with the different surgeons. Some had simple prostatectomy either through the perineal route or through the suprapubic incision at one or two stages, while others had radium or X-ray or both radium and X-ray in addition to surgery. The radical prostatectomy of Young has not been employed in any of the cases in this series. More recently a more conservative treatment has been adopted. The cautery punch has been used to relieve obstruction and radium either in combination with X-ray or alone has been given to retard the growth, and later on a comparative study between this conservative therapy and major surgery will be detailed. The punch operation was performed in one or more sittings according to the need of the individual case. Radium was formerly given by inserting needles containing 12.5 milligrams of radium into the prostate and leaving them in the glandular tissue for a certain length of time according to the amount of the treatment required. More recently radon seeds from 1 to 2 millicuries each are used. From six to ten seeds are implanted into the prostate and vesicles with the aid of two small trocar needles inserted though the perineum. Deep therapy is usually given a few weeks following the radium, although at times it precedes the radium implantation. The X-ray is generally administered in divided dosage regulated by the X-ray department. It is the general practice of the Service to repeat the X-ray and radium treatments at intervals of two to four months. In some cases where surgery is believed contraindicated, only radium and X-ray are given. It is the policy of the service to supplement surgical treatment of all cases of carcinoma of the prostate by radium or X-ray therapy or by the combined radium and X-ray treatment, but this is not always possible due to various reasons beyond the control of the Service. Thus some of the patients in this series passed through the Service without having a complete treatment.

Before proceeding to the discussion of the results of the different therapies, it may be of interest to mention a few of the experiences of this clinic in regard to the treatment of carcinoma of prostate. The experience of the Service at Barnes' Hospital with ra-

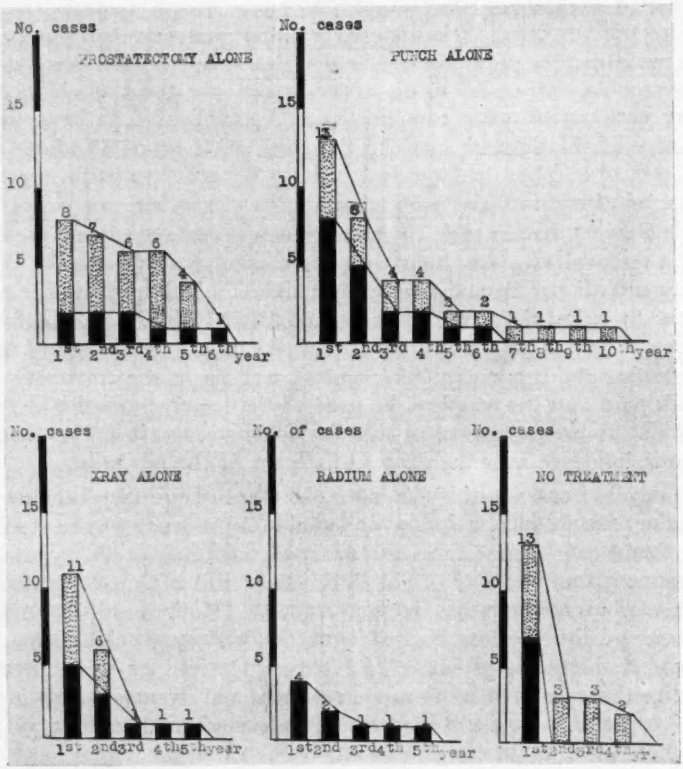
dium therapy coincides very well with that of the other clinics. The enlarged and stony-hard cancerous prostate readily reduces in size and becomes softer after radium or radon implantation. It is observed, however, that radium causes more tissue reaction than radon. In one of the cases of carcinoma of the prostate treated with radium needle implantation a prompt reaction occurred which resulted in a dense fibrosis of the orifice which required sharp dissection excision. Histologically the tissue was entirely scar. A recontracture promptly occurred which necessitated a permanent suprapubic drain. In using radon seeds, we have never noted any such unfortunate complication. A number of patients with cancer of the prostate came to the clinic with practically hopeless metastases. They had marked urinary disturbances with a great deal of discomfort and pain on urination. It is the experience of this Service that in such cases the punch operation is very useful. The removal of a few bites with the cautery punch generally renders urination free and practically painless. This permits the patient to enjoy the few remaining months of his life in comfort. Deep X-ray therapy is found to be very useful in shrinking and softening the carcinomatous gland as well as in the treatment of back pain and the sciatica-like pain of the lower extremities. According to the experience of this Service, however, it has no therapeutic influence over the deep seated pain of the hip joint.

Only 143 cases in this series of 218 cases of primary carcinoma of the prostate have a follow-up suitable for a study of the results of treatment. These cases are grouped according to the types of treatment they received. The duration of life after treatment by the various methods has been averaged. Of these 143 cases of cancer of the prostate treated with the various combinations of therapy, thirty-six patients (25.1 per cent) lived or were known to live three years or more after treatment and twenty-five of these (17.4 per cent of the 143 cases) lived or were alive four years or more after treatment.

The analysis of results of treatment in this series of cases has been supplemented by graphic representations showing the duration of life after the different types of therapy. Those patients dying while in the hospital as the result of operation, or complications thereof, or those in whom the disease had developed beyond any therapeutic aid and were brought to the hospital to pass

their few remaining days in as much comfort as possible, are not included in the graphic series, since their inclusion would not give a true representation of the benefits derived from therapy. The

GRAPH I. DURATION OF LIFE AFTER DIFFERENT TYPES OF THERAPIES

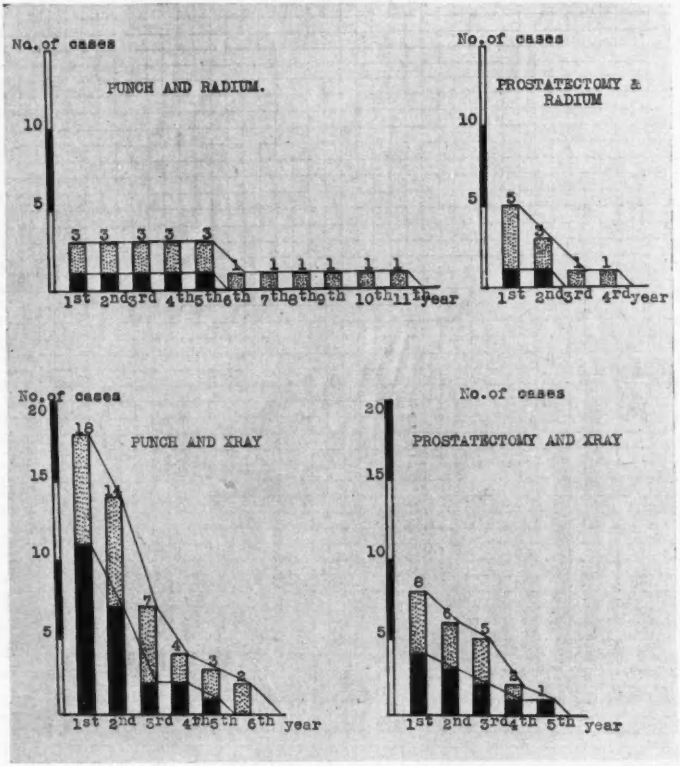


graphs are intended to show the relative value of the different types and combinations of therapy in prolonging life.

The first column to the right of the scale indicates the total number of cases treated by that particular type of therapy, and the black portion of that column indicates the total number of deaths.

The drop in the black portion of the column from year to year would therefore indicate the number of deaths during the preceding year, and the drop in the total column would be due to deaths,

GRAPH II. DURATION OF LIFE AFTER DIFFERENT TYPES OF THERAPIES



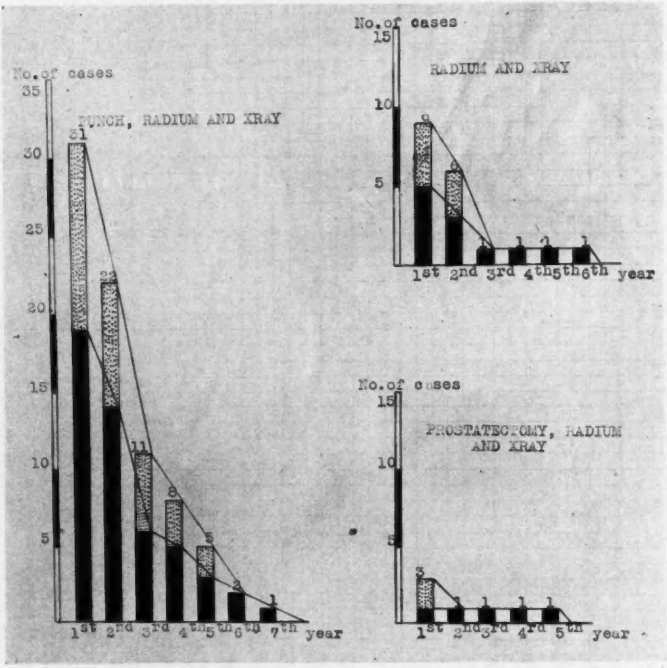
those patients in whom treatment had extended only to that length of time and those in whom a follow-up could not be obtained.

Graphs 1, 2 and 3 show the results from different types of treatment and Graphs 4 and 5 are composites of these, showing the

results from treatment other than surgery, and from all prostatectomy and cautery punch cases alone or in combination with radium or X-ray.

A discussion of the graphs will be limited to IV and V, the non-

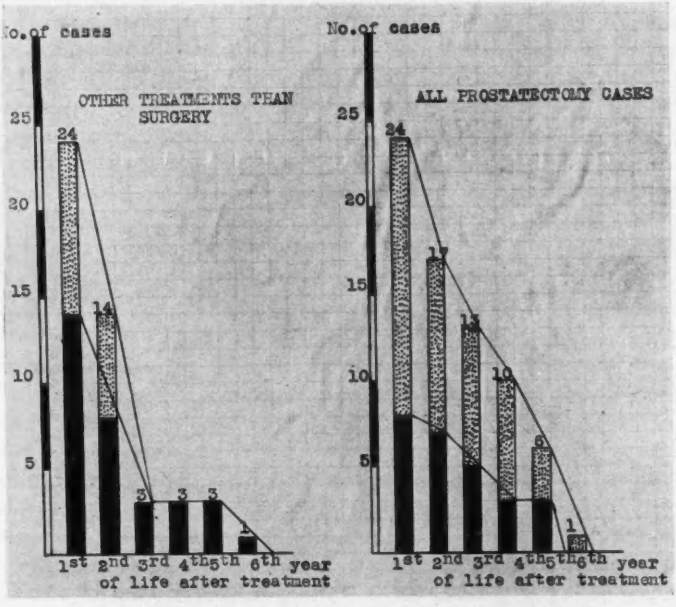
GRAPH III. DURATION OF LIFE AFTER DIFFERENT TYPES OF THERAPIES


No. of cases
PUNCH, RADIUM AND XRAY
1st 2nd 3rd 4th 5th 6th 7th year
No. of cases
RADIUM AND XRAY
1st 2nd 3rd 4th 5th 6th year
No. of cases
PROSTATECTOMY, RADIUM AND XRAY
1st 2nd 3rd 4th 5th year

surgical and surgical groups and the cautery punch cases, with occasional reference to the preceding graphs. Those cases treated non-surgically, that is, with radium or X-ray, or a combination of both, show a sudden drop in the curve the first two years, leaving only three patients or 12.5 per cent living over two years and only one patient living more than five years, that patient dying in the

sixth year. Those patients having prostatectomy alone were naturally patients who were good surgical risks. Fifty per cent of the patients who lived several years after the operation were clinically benign cases, carcinoma having been detected in an otherwise benign hypertrophy by histologic examination. Naturally the

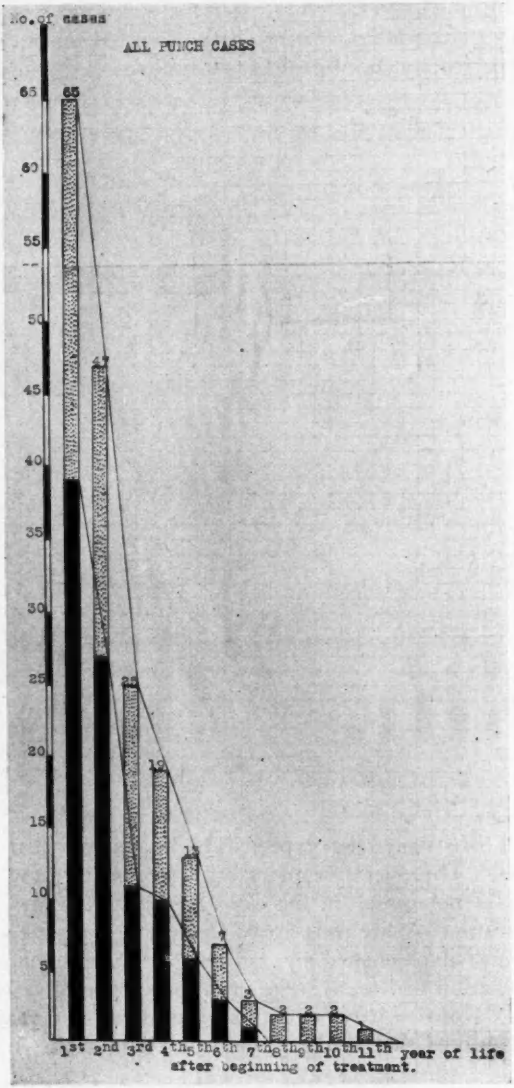
GRAPH IV. DURATION OF LIFE AFTER DIFFERENT TYPES OF THERAPIES



duration of life would be expected to be longer than in frank cancer cases. The operative mortality in prostatectomy done for cancer was 17 per cent. In the cases of prostatectomy alone, the average duration of life was forty-four months; patients having prostatectomy supplemented by radium and X-ray therapy alone or in combination had an average duration of life of only twenty-five months. Not one patient of this group lived five years.

It is to be noted that in the general graph (Graph 4) for pros-

GRAPH V. DURATION OF LIFE OF PATIENTS
TREATED WITH PUNCH OPERATION



tatectomy cases there is a more gradual decline in the curve. This is due to the simple prostatectomy cases including the clinically benign lesions. The drop in the curve is more gradual but in itself is pronounced. All of these patients but one died within 5 years, and that one is living in the sixth year.

It seems definitely as unsurgical to attempt to gouge out a carcinoma of the prostate suprapubically as it does to attempt the same type of enucleative procedure for a cancer of the breast.

Since the completion of the tabulation of this paper about a year ago, I have analyzed all the punch cases from many different angles and standpoints, and will present them to date. It will be noted on Graph 5 that there is a sudden drop in the curve for the first two years which results from the fact that the majority of these patients were very poor risks, may entirely inoperable. From this time on, unlike the prostatectomy graph, the curve is more gradual. At the end of three years 29 per cent are living and at the end of five years 10.7 per cent still survive, and one patient is still living after ten years.

A critical analysis of the punch cases follows:

There were eighty whites and one colored. This disproportion is due to the fact that the majority of these patients were private ones. In this group there were forty early cases and forty-one advanced cases. I have differentiated the early cases as those in which there were localized nodular areas in the prostate without evidences of extension beyond its confines, the seminal vesicles, membranous urethra and rectum apparently normal, and without demonstrable evidence of metastases. This of course is quite indefinite, since it is impossible to determine whether or not the deep pelvic glands may be involved. In a number of instances the prostates showed apparent early lesions, the diagnosis of cancer being difficult, and yet there was pronounced dissemination of the disease.

Of the eighty-one cases, I have been able to get a follow-up record of sixty-nine or 85 per cent. Of these, twenty-seven patients are living and forty-two have died. Thirty of these died of cancer, twelve of other causes such as pneumonia, heart conditions, apoplexy, pyelonephritis, and following a later operation done elsewhere. Two deaths resulted from the punch operation; in both instances the individuals were extremely depleted.

The time of death is indicated in the following table:

6 mos. to 1 yr.	2 yrs.	3 yrs.	4 yrs.	5 yrs.	6 yrs.	over 6 yrs.
8 cases	11	3	1	3	3	1

In the total series of cases 83 per cent had the punch operation combined with X-ray or radium or both. Of these 67 per cent had single operations and 33 per cent multiple. Thirteen and one-half per cent of the multiple operations were for recurrence of the disease. Seventy-four per cent were treated with X-ray, 52 per cent with radium. Seventeen per cent of the total number were treated by the punch alone. The majority were patients with extensive metastases upon whom the relief of obstruction alone was designed; a few refused X-ray and radium.

The results of the different combinations of treatment are as follows:

First Group: Radium, X-ray and punch—thirty-five cases or 43 per cent. Those who died lived an average of twenty-seven months. Those who are living average twenty-five months since beginning of treatment. Many of them are in good condition.

Second Group: X-ray and punch—twenty-five cases or 30 per cent. Those who died lived an average of seventeen months. Those who are living average thirty-eight months since the beginning of treatment.

Third Group: Radium and punch—seven cases or 9 per cent. Those who died lived an average of thirty months. Those who are living average ninety months since beginning treatment. This latter figure is striking but concerns only two patients both of whom had low grade malignancy, and have remained well—one, five years, and one, ten years. In both instances the specimen removed with the punch showed cancer.

Fourth Group: Punch alone—fourteen cases or 17 per cent. Those who died lived an average of twenty-four months.

Those who are living average thirty months since beginning treatment.

Of the forty early cases fourteen patients lived three years or more—35 per cent. Of the forty-one advanced cases six patients lived three years or more—14.6 per cent. Of the fourteen patients in the early cases who lived over three years, five had small prostates, seven had moderate enlargements, two extreme growths; of the advanced cases, one small and five larger growths.

There were therefore but six patients with small prostates of the twenty who lived more than three years, and fourteen with larger ones. This demonstrates a decided tendency of the larger growths to be less malignant or at least more responsive to therapy.

Of this group of twenty cases, fourteen early cases received treatment as follows: X-ray and punch, two cases; radium and punch, four cases; X-ray, radium and punch, five cases; punch alone, three cases. Of this latter group of "punch alone" cases, the punch specimen was positive for cancer in one, one patient died four years later of cancer, and one is living with definite evidence of general carcinoma.

The six late cases received treatment as follows: X-ray and punch, three cases; X-ray, radium and punch, three cases.

In other words 29 per cent of all the patients lived more than three years. Deducting the thirteen cases in which the punch alone was done because these patients were inoperable and the operation was simply done to relieve urinary obstruction with no attempt to abate the disease, there were sixteen patients or 30 per cent living more than three years.

Of these twenty cases the specimens removed from the orifice by means of the punch showed definite cancer in fifteen or 83.3 per cent, benign hyperplasia in three or 16.6 per cent, and in two cases there was no examination of the specimen. This definitely indicates the presence of cancer at the internal orifice of the prostate. In many instances the disease appeared to be localized and early. Ten of the twelve early cases gave a positive picture of cancer. Ten per cent of the total number of patients have lived or are living more than five years. Six of these were early cases, two advanced, five showed enlargement, three were small. Of the two advanced cases, one was small and one was large, both controlled by repeated massive doses of X-ray therapy. In seven of the eight patients, the tissue removed by the punch showed carcinoma. The treatment employed in these patients was X-ray and punch in two instances, radium and punch in two, X-ray, radium and punch in two, punch alone in two. Specimens were removed from sixty-four patients; in fifty-two or 81 per cent positive evidence of cancer was obtained, 19 per cent benign. In other words the removal of specimens from the internal orifice of the bladder in obstructions suggestive of carcinoma will aid in disclosing the true

diagnosis of the disease in 81 per cent of the cases, thereby stamping it as a valuable aid in such diagnosis.

RESULTS

There are twenty-six patients living who had the cautery punch operation. The results of their operations are designated below and range from six months to ten and a half years.

Time	No. Cases	Result
6 months	1	Complete relief of obstruction—in good shape.
6 mos. to 1 yr.	4	All with relief of obstruction.
1 to 2 yrs.	8	5—relief of obstruction. 1—did not return as he was advised. 1—has recurred and is about to undergo another operation. 1—received no benefit.
2 to 3 yrs.	3	2—complete relief of obstruction. 1—poor result—prostatectomy within the last 6 months by another surgeon.
3 to 4 yrs.	3	2—complete relief of obstruction. 1—on catheter life (tremendous prostate).
4 to 5 yrs.	3	All with complete relief.
5 to 6 yrs.	2	Both with complete relief.
9 yrs.	1	Symptomatically perfect—carries 2 ounces of residual. Good general condition.
10.5 yrs.	1	No residual—good general condition.

Of the total number of cases 77 per cent received complete relief of obstruction, 23 per cent were either partially benefited or received no relief.

Forty-two patients have died. Of these, there are records of the condition of the bladder at the time of death of forty cases.

Thirty died from cancer—71 per cent. Of these there are definite records as to the bladder condition in twenty-eight.

Twenty had complete relief of obstruction—71 per cent.

Six had partial relief. Three of these were in such poor condition as to preclude further surgery of even this minor type. The other three refused further surgery.

Twelve died from other causes—29 per cent: Of these two died from hemorrhage following operation; both were extremely poor risks with general metastases and one a hemophiliac. Five had complete relief of obstruction—50 per cent. Five had but partial relief.

Of the sixty-four cases which have been studied forty-six or 72 per cent obtained complete relief of obstruction.

SUMMARY

The frequency of prostatic cancer warrants attention and demands early recognition.

Chronic inflammation of the prostate may be a predisposing cause.

The cautery punch operation in conjunction with radium and X-ray therapy appears to be the method of choice for relieving obstruction and retarding the progress of the disease.

Of the cases reported 72 per cent received complete relief of obstruction.

Twenty-nine per cent of the patients lived or are living more than three years, 10 per cent more than five years, a longer duration of life than that afforded by prostatectomy.

The mortality from the operation in spite of the fact that it was done in many instances upon extremely ill patients upon whom prostatectomy would not have been considered, is 2.5 per cent.

The mortality rate from prostatectomy in this disease in our clinic is 17 per cent.

Hospitalization has been less.

The punch operation affords a definite means of accurately diagnosing cancer of the prostate in 80 per cent of all cases, early or late, which indicates that the disease even in apparently early cases is usually throughout the substance of the gland.

We wish to express our thanks to Dr. John F. Patton, who assisted us with this paper.

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DISCUSSION

DR. ARTHUR L. CHUTE (Boston): I have been greatly interested in these papers. I feel they have to do with one of the greatest, if not the greatest and most puzzling problem, that there is before men who do urinary surgery; namely, how best to care for cases of carcinoma of the prostate. For a number of years I have held the discouraging opinion that we were not curing carcinoma of the prostate by the use of radium. I am especially impressed by the fact that the different doses that Dr. Smith has given have led to practically the same result. Dr. Smith's paper has heightened my belief that as yet all we can do in carcinoma of the prostate is to palliate and that at present we have come down really to the question of what is the best palliation we can offer the individual presenting this condition.

While it is certainly a discouraging showing, as far as the efficacy of radium is concerned, it seems to me it presents the real facts; it certainly does, as far as my experience is concerned. The reason of this is that by the time we can make a diagnosis of carcinoma of the prostate, it is already considerably advanced, too far advanced for any hope of complete eradication. This is because the early symptoms of carcinoma of the prostate do not differ from those of benign hypertrophy, and even our earliest diagnoses of carcinoma of the prostate must depend upon changes in the gland, as felt by rectum. At the time these are evident the disease is already so advanced that it has extended in places as far as the true capsule of the gland and sometimes even further, and it is impossible to remove it all by operation; further there is no selective action of radium for malignant disease, and besides it is impossible to implant radium so accurately as to destroy the whole gland —the more heroic attempts simply make the patient the more uncomfortable.

In my opinion some of the instances in which cure has been attributed to the use of radium have been due to a misunderstanding of the very slow rate at which some cases of carcinoma of the prostate progress. A patient who died in April, 1932, was first seen in June, 1923, nearly nine years previously, with a little urinary irritation, a prostate a little increased in firmness on one

side, a little denseness of the prostate on radiography but with only one-half ounce of residual. Carcinoma was suspected but the man went on very comfortably until June, 1927, a period of practically four years, at which time, due to his increasing residual, then 4.5 ounces, I removed suprapubically in this instance a mass that was an adeno-carcinoma. Following this he had over three years of very good health, during which he made long foreign trips, and so forth. Early in 1931 his symptoms began to recur and his residual to reappear, so a perineal removal was done and radium needles implanted, this last as much for his mental comfort as for anything else; microscopically the removed tissue was adeno-carcinoma. This patient lived about fifteen months following his second operation.

Had radium been used at his first operation, it would have been easy to have thought that it had had a beneficial effect. I do not think this is a very unusual course for a carcinoma of the prostate to take.

Dr. Smith's paper shows us that we cannot depend upon radium as a cure for carcinoma of the prostate; it does not even convince me that it is the best palliation. It should stimulate us to further study of this, so far, discouraging subject.

Dr. Hugh H. Young (Baltimore): Dr. Smith is to be congratulated upon the excellent results which he has obtained with the radical operation for cancer of the prostate. Among his forty cases are a good many which offered very little chance of a radical cure, cases in which I have not employed this operation. It is interesting to note that he has found that the ultimate result was that the patient remained free from pain and urinary discomfort as long as he lived, in the majority of cases, and died from metastases rather than local recurrence. In favorable cases he has also had a large per cent of radical cures and permanent good results. I have now used this operation in thirty-nine cases, a few of which were unfavorable, but the majority earlier than many of Dr. Smith's cases. There were four deaths, a mortality of 10 per cent, but in the last thirty-three cases, there were two deaths, a mortality of 6 per cent. One of these deaths was due to unintentional ligature of a ureter, manifestly an operative fault. The operation is therefore no more dangerous than perineal prostatectomy for benign hypertrophy and the mortality lower than the ordinary

suprapubic prostatectomy, which, in my opinion, should never be employed in cases of carcinoma of the prostate (though in rare cases in which the carcinoma is within a hypertrophied lobule, a radical cure or good immediate result may be obtained by simple suprapubic enucleation). A very detailed pathologic study of our specimens has shown that in the large majority of cases the posterior lamella, or lobe, was involved, and in many cases no other portion of the prostate was involved. Since changing our technic so as to preserve the anterior pelvic fascia, which separates the prostate from the vessels and nerves in the space of Retzius, over 50 per cent of the cases have had complete urinary control, many with absolutely normal urination. Among those patients who left the hospital there are four living and well two years after operation, one three years, two four years, one five years, one six years, two seven years, one thirteen years and one seventeen years after operation. Many of the cases were aged men who have died natural deaths without any evidence of recurrence. After a careful study it seems safe to say that well over 50 per cent of the patients who left the hospital have had no recurrence. But this is to be expected, as the prostate is more surrounded by capsules and fascias than any other organ in the body. As the growth progresses it goes upward in the great majority of cases, and in some slowly, so that the possibilities of a radical cure by the technic which I proposed are very good. In this series of thirty-nine cases there are a good many in which I would not operate with the expectation of a radical cure, but as Dr. Smith has found, these patients have been remarkably free from pain and other urinary symptoms, so that the operation is not regretted.

The great difficulty is that most patients arrive too late for a radical cure. We should endeavor to persuade practitioners of medicine to include rectal examination in all physical examinations, especially in men past middle age, and to be very suspicious of a markedly indurated area in the prostate, even if only a small, smooth nodule. They should be told that such cases should be subjected to a perineal operation, at which it will be possible to excise the nodule and determine whether it is malignant, before subjecting the patient to an extensive radical operation.

Dr. Osler used to remark that the difference between a good physician and a poor one is that the former knew how to do a

rectal examination. If this could be brought home to the medical profession, the percentage of cures with the radical operation and cancer of the prostate would be far higher than cancer of any other portion of the body.

DR. GEORGE G. SMITH (Boston): I would like to sound a slightly different note than that which Dr. Chute has sounded when he said that palliation was the only possible course to follow in recognized cases of cancer of the prostate.

I am entirely with Dr. Hugh Young in his estimate of the value of total perineal prostatectomy, and I would like to record, very briefly, the fact that in the last fourteen years I have operated in forty-one of these cases with four hospital deaths. Thirteen patients died of cancer, the average life after operation being twenty-one months. The longest life after operation was seven and one-half years. There are alive with recurrence, four—one five months, one three years, one four years, and one six years. There are alive and apparently well, out of these forty-one cases, sixteen cases: under one year, six; one to two years, four; two to three years, three; four years, one; five years, one; six years, one. I am not in the seventeen-year class yet, but I hope, if I live long enough, I shall be.

Unfortunately the number of patients on whom this operation can be done is relatively small. There are in my practice only about four a year. With others, what are we going to do? We see in the literature frequent reference to the punch operation and treating with radium, and it was the idea of finding out whether the treating of the patient with radium amounted to anything, or not, that led me to make this study.

I agree with Dr. Caulk entirely that the punch operation will relieve these patients oftentimes for a year or two, or possibly longer. I think that some of the newer methods of resection of the bladder neck will undoubtedly prove highly valuable. The question is, whether in these cases in which only palliation can be done, we can gain anything by radium treatment or by X-ray treatment. I feel that X-ray treatment will relieve, to a remarkable degree, the pain in the back which comes from metastasis, and I believe that it will sometimes, as I have shown in another paper, cause a fibrosis of the prostate which can be definitely shown on microscopic examination.

As for the use of radium, I have already expressed my view about that. I would simply sum that up by saying that I think we must use it without hope of a cure, using it in the same way we use X-ray, with the idea of giving a small dose to produce in the prostate gland a possible fibrosis which will limit the growth of cancer.

PROSTATIC OBSTRUCTION RELIEVED BY SUPRAPUBIC DRAINAGE FOLLOWED BY TRANSURETHRAL RESECTION

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Control of bleeding by electrocoagulation has made possible relief of urinary obstruction, the result of prostatic hypertrophy, by transurethral methods. I first employed electrocoagulation in controlling bleeding following punch operations in 1925, and the experience gained with its use in more than 300 subsequent cases in the last seven years forms the basis for the observations that follow.

This method of hemostasis not only makes possible transurethral operations, but I believe will be found to be the chief factor in limiting their application. When bleeding is controlled by electrocoagulation, the effect on the tissues involved is such that there is a limit to the areas that can be so treated without untoward results, and even after this limitation has been accepted, the method can be employed successfully only if a definite rule is observed; namely, that urinary obstruction, as expressed by the presence of residual urine, be completely relieved.

When tissue is subjected to the action of a high frequency current the effect produced can be detected in three horizontal layers, depending on width and depth of the tissue affected, the length of exposure and on the intensity of the current. The surface will be blanched by coagulation; the layer of tissue just below is killed but not coagulated. If the current has run through this layer long enough to heat it appreciably, vacuoles will be seen on section, where bubbles of steam have collected. Beneath this layer is the third, in which will be found much congestion, edema, hyperemia, and all the classical signs of an inflammatory reaction. Throughout the middle layer of dead tissue the blood vessels are thrombosed, and this thrombosis, together with the layer of coagulation above, prevents immediate postoperative absorption. Therefore, tissues are frequently removed by this method with no immediate rise in temperature or pulse rate because absorption from the

operative site, of toxic products elaborated either by destroyed tissue or by bacteria, has been prevented.

Under such conditions, if the removed tissue has weighed but 5 or 10 gm., the patients frequently leave the hospital on the third or fourth day, voiding freely and wondering at their former dread of prostatic disease. But when the excision has resulted in removal of larger amounts of tissue, organization does not always occur with the same freedom from complications. For, if the residual urine has not been completely eliminated, the destroyed tissue gradually dissolves in the urine and furnishes an ideal culture medium for secondary infection, and areas of necrotic tissue appear from which serious secondary infection develops. If, in addition to the residual urine, large areas of such necrosis exist as a result of too extensive coagulation, the probabilities of rapid and uncomplicated convalescence are impaired. The teaching that intravesical surgical procedures demand postoperative drainage is still applicable, and when resection necessitates removal of a considerable amount of tissue, let us say in excess of 20 gm., removal of this amount of tissue from the confines of the prostatic urethra in small portions means that more than twenty pieces of tissue will have to be excised. If, under such circumstances, high frequency current is employed to control the bleeding, the resulting coagulation will be excessive, and final absorption of the coagulated tissue, as well as organization, of necessity will take longer than would be the case were the same amount of tissue excised by a knife and the bleeding points controlled by ligature.

Therefore, whenever the obstructing tissue is large in amount, institution of preliminary suprapubic drainage insures greater safety, and makes it applicable in most cases of benign prostatic hypertrophy. The suprapubic drain, by insuring constant removal of toxic exudates, reduces infection to a minimum. It also puts at rest the vesical neck, and so prevents the efforts at premature expulsion of necrotic tissue, the tearing away of which before organization has occurred is the most frequent cause of delayed bleeding. Such bleeding in itself would seldom be serious did clots not form, the efforts at expulsion of which keep up the bleeding, and so institute a vicious circle.

The problem, then, is to determine which cases are best treated by transurethral methods, which by prostatectomy, and which by

a combination of preliminary cystostomy and subsequent transurethral resection. At The Mayo Clinic we have taken 20 gm. of tissue as the extreme amount it is advisable to remove through the urethra.

In a study of 250 cases treated by resection in the last seven years so great an amount was removed but once, and so could be considered the extreme. In 204 cases (81.6 per cent) 5 gm. or less was removed. If it is estimated that two-fifths of the hypertrophic tissue removed at prostatectomy represents the amount that is actually obstructing the urethra, one may consider any prostate gland, the hypertrophic portion of which weighs less than 50 gm., as suitable for transurethral resection. Of 575 cases in which prostatectomy was performed at The Mayo Clinic in the last three years, in but 32 per cent of the cases did the removed tissue weigh more than 50 gm., a figure that also represents the percentage of cases of prostatic hypertrophy being treated by prostatectomy at the present time. But included in this 32 per cent of cases in which the hypertrophic portion of the prostate glands weigh more than 50 gm. are many patients who are first seen with complete retention, very extensive renal impairment, and often grave cardiac injury, not to mention, in some cases, extreme senility. Such patients require suprapubic drainage at the earliest moment consistent with safety, and needless to add, relief of their obstruction should be undertaken with the minimum of risk. The institution of suprapubic drainage greatly extends the applicability of transurethral resection for reasons I have stated, and, as a result, at the clinic we are finding it possible to relieve of their suprapubic drains men whom we have deemed in the past to constitute too great risks to warrant prostatectomy.

I had, up to January, 1932, removed the obstructing portion of the prostate gland in forty-four cases in which cystostomy had been performed previously. In nineteen of these, the cystostomy had been done as the first stage of prostatectomy in two stages, but the decrease in the size of the gland after drainage, or more frequently the very poor physical condition of the patient, made the transurethral method of removal seem preferable. One patient, aged seventy-eight years, died of general sepsis on the thirty-third day after operation, but when one considers that the group was composed entirely of patients deemed to constitute too great risks

for primary prostatectomy, and that most of them were unsuited even for secondary prostatectomy, the loss of but a single patient seems noteworthy.

Among the forty-four patients were three with carcinoma of the prostate gland, who previously had undergone suprapubic drainage, and, becoming most dissatisfied with the arrangement, demanded relief. One of these patients, aged seventy-three years, died of embolic pneumonia. In the remaining twenty-two cases in which cystostomy had been performed, the transurethral method of treatment was used because the urinary obstruction was not great. In twelve of these twenty-two cases, recent resection of a diverticulum made further major surgery a thing to be avoided, and in the remaining ten, removal of stones from the bladder had resulted in so much diminution in the size of the prostate gland that prostatectomy hardly seemed justified for removal of so comparatively small an amount of tissue.

Recent letters have been received from thirty-eight of the patients who accepted transurethral resection after previous cystostomy. Twenty-nine expressed themselves as satisfied with the results, whereas nine were disappointed. One of the nine was of the nineteen patients for whom resection had been chosen to replace prostatectomy as the second stage of an operation in two stages.

Therefore, although transurethral removal of obstructing prostatic tissue has been made possible by electrocoagulation, the applicability of transurethral resection has been extended by performance of suprapubic cystostomy prior to resection. Suprapubic cystostomy is especially useful in operating on patients who are suffering some serious impairment of their parenchymatous organs.

RESULTS IN 385 CASES OF PROSTATIC RESECTION BY THE DAVIS METHOD

INCLUDING ANALYSIS OF QUESTIONNAIRES RETURNED IN 278 CASES

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An analysis of the results obtained by any surgical procedure for the cure or relief of pathologic conditions by means of a questionnaire is unsatisfactory, but it is the only way to ascertain progress made when the patients cannot be induced to report for personal investigation.

With a desire to know just what results we have secured by removing the obstructing portion of the prostate gland by resection, according to the plan now carried out in our clinic, we have attempted to analyze clinically, by questionnaire and personal examination, 385 cases coming under our care during the last five years. Of the cases studied in this series 229 patients returned their questionnaire and forty-nine reported for examination. In 107 cases definite replies to questionnaire have not been received to date.

In this analysis we find that the clinical results obtained are better in cases operated upon more than six months previously. There is nearly always some tenderness accompanied by tenesmus during and following urination for several months after the operation, but this finally subsides. We presume that with time the remaining portion of the gland becomes atrophied and retracts so as to enlarge the vesical opening and enable the patient to empty the bladder without difficulty. A number of these cases have been cystoscoped from one to five years after operation and the prostatic urethra was found unobstructed by the remaining portion of the gland.

We are reporting the average length of time these patients remained in the hospital after operation, the patients having residual urine and the amount, the number having epididymitis, its duration and severity, the percentage of malignancies, the number of cases undergoing a second operation, the patients' present condition clinically from one month to five years after operation, the

number of deaths and causes, and the length of time death occurred after operation.

Such complications as urinary fistulæ and incontinence need not be mentioned except to stress the advantages resection has over prostatectomy, perineal or suprapubic. Incontinence is the only one of these that could occur. If the external sphincter is not injured during the operation, such a result is almost impossible in the non-malignant cases and certainly if the resection does not extend further anteriorly than the verumontanum. We have had one case of temporary incontinence as a result of a urethral abscess anterior to the verumontanum, involving the external sphincter. This resulted from dilating a stricture of small caliber in the bulbous urethra at the time of operation.

An analysis of our cases shows the following:

Time since operation:	Number Operated	Number of Replies
1927—[5 years]	26	17
1928—[4 years]	36	24
1929—[3 years]	42	25
1930—[2 years]	66	36
1931—[1 year]	159	128
1932	56	48
Totals	385	278
Number of questionnaires returned		229
Number presenting themselves at office for examination		49
Total		278

ANALYSIS OF QUESTIONNAIRES AND RE-EXAMINATIONS

1. Do you have any difficulty in emptying your bladder?
   Yes—16 No—247

2. Do you empty your bladder completely? If not, how much residual left? [Please have your physician use catheter after voiding to ascertain the amount.]

10 c.c.	2
15 c.c.	5
30 c.c.	2
1 oz.	6*
2 oz.	3
3 oz.	1
Questionable	8

*One of these patients had first Bottini operation ten years and second Bottini five years prior to resection.

3. Do you suffer pain during or after passing your water?
   Yes—15 during No—245
   3 after

4. How often do you rise at night to empty your bladder?

0	59
1	110
2	48
3	29
4	14
5	3

5. Did the operation strengthen or weaken your sexual power?

Strengthened	114
Weakened	42
No change	101
Complain of ejaculation into bladder	6

6. Do you have any incontinence or trouble in controlling your water?

Incontinence	3
Slight leakage at times when bladder is full	5
Frequency	17

7. Have you gained or lost weight since the operation?

Gained	93
Lost	37
No change	133

8. If patient is not living, give date and cause of death.
   [1] W. C. S.....carcinomatosis—13 months.
   [2] Rev. W. C. P.....carcinomatosis—3 years, 9 months.
   [3] Rev. J. C. M.....cardiac—2 years, 6 months.
   [4] L. H. M.....dysentery—3 years.
   [5] H. C. M.....uremia—2 years, 9 months.
   [6] Rev. E. L. T.....pneumonia—3 months (post influenza).
   [7] Rev. J. F. A.....cardiac—1 year, 4 months (prostatectomy five years before).
   [8] J. L. J.....carcinomatosis—1 year, 3 months.
   [9] J. C. C. N.....cardiac, senility—3 years, 2 months.
   [10] A. A. V.....coronary disease, angina—3 weeks. (Several attacks before operation.)
   [11] W. R. B.....Acute hemorrhagic nephritis—3.5 weeks.
   [12] W. H. D.....carcinomatosis—5 months.
   [13] Dr. W. A.....cardiac—3 weeks.
   [14] J. M.....acute nephritis—4 months.
   [15] E. H. W.....carcinomatosis—6 months.

Reactions (Temperature):

104 F.	4
103 F.	27
102 F.	29
101 F.	41
100 F.	59
99 F.	63
Normal	40

Chill preceded temperature in 32 cases.
Shortest duration of temperature—14 hours.
Longest duration of temperature—9 days in one case.
Average duration of temperature—1.5 days.
Accidents—4.
1 rupture of diverticulum.
3 secondary hemorrhages (two on the 10th and the other on the 11th day).

Longest stay in hospital—

19 days—	1 case*
18 days—	3 cases*
17 days—	1 case*
16 days—	6 cases*
15 days—	4 cases*
14 days—	4 cases
13 days—	2 cases
12 days—	3 cases
11 days—	6 cases
10 days—	11 cases
9 days—	3 cases
8 days—	5 cases
7 days—	50 cases
6 days—	22 cases
5 days—	104 cases
4 days—	12 cases
3 days—	2 cases
2 days—	1 case
Not hospitalized—	22 cases

Average stay in hospital—6.6 days.

Carcinoma—42 cases.

Epididymitis—10 cases—not severe enough to require anything except palliative treatment.

Second operation—15 cases [11 of the earlier cases required a second operation].

*We have performed this operation upon patients from eighteen states and we always keep those from a distance in hospital or hotel at least two weeks following operation because of the possibility of secondary hemorrhage.

A COMPARISON OF CLINICAL AND PATHOLOGIC CHARACTERISTICS OF FIFTY PROSTATIC BARS AND SCLEROSES

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The phrase "prostatic bars and fibroses (or scleroses)" expresses inaccurately but intelligibly a familiar clinical condition. By it we indicate a disorder characterized by retention due to mechanical obstruction at the bladder neck and associated with no great enlargement of the prostate. (Elimination of bladder stone, paralysis or diverticulum as the sole cause for retention of urine and of prostatic carcinoma and tuberculosis are assumed.)

But today it is unprofitable to think loosely on this subject. For the third time in my experience the wave of enthusiasm for an operation that promises to replace prostatectomy is rapidly advancing. The hopes felt by many urologists today for the future of the Stern-Davis-McCarthy electrical resection of the prostate are echoes of the medical literature at the beginning of the century concerning castration and vasotomy and of the immediately ensuing Bottini period. Indeed, one of the minor crests of the latter wave, the Chetwood operation, quite upset me for a number of years so that I know the symptoms. Diagnosis and prognosis are alike colored by the rosy light of hope, founded upon a new instrumental technic, temporarily blinding us to the prosaic realities of pathologic prognosis.

The so-called minor operations by various urethral punches have successfully attacked the prostatic bar but without guaranteeing against subsequent enlargement of other portions of the prostate. They have failed to prevent the progressive enlargement of lateral and, generally speaking, of median lobes. They have succeeded in relieving retention due to inflammation or fibrosis at the bladder neck but have not been singularly successful in relieving retention due to inflammation or fibrosis within the prostate. The newer operations will do better; how much better remains to be seen.

In a recently published paper[2] we have reviewed our clinical experience with various operations upon the bladder neck and cited cases to illustrate the clinical course of these patients. The observations therein may be thus summarized.

We have favored the suprapubic rather than the urethral approach for difficult problems.

In estimating bladder neck obstruction we have trusted and shall continue to trust the finger rather than the eye.

Our therapy has been interwoven with the usual dilatation, massage and cajolery so difficult to classify.

Not even lobar prostatectomy assures against recurrence of retention, whether by hyperplasia or fibrosis.

The "minor" operations wholly fail to prevent recurrence of hypertrophic obstruction.

After years of hesitation we have finally concluded that we do not need Crabtree's operation.

In order to add to this record we have analyzed fifty-five cases whose history is clinically complete at least to the time of leaving hospital after operation and pathologically as far as microscopic examination of tissue obtained at operation could make it. Re-examination of this tissue was done in most instances at a considerable period from the time of operation and, therefore, the pathologic observation is defective because in some instances only one or two slides were preserved, of prostate perhaps and not mucosa, or vice versa.

This defect, however, amounts to minimizing of the number of cases characterized by prostatic fibrosis or hypertrophy and increasing the number attributed simply to bladder neck inflammation and fibrosis.

The cases selected for this study (a) presented urinary retention and (b) a prostate whose lobes bulged little, if at all, as seen by cystoscope or felt by rectum; (c) they have been operated upon, and (d) the slides remain in our possession for simultaneous comparison.

Our pathologic material may be classified as showing lesions of the bladder neck, lesions of the bladder muscle and lesions of the prostate.

TABLE I. SUMMARY OF LESIONS

BLADDER NECK

Inflammation	8
Fibrosis	6
Ulcer	7
Fibrosis, Ulcer	4
Ulcer, Cyst	1
Subcervical Hypertrophy	1
Fibrosis, Subcervical Hypertrophy	3
Ulcer, Fibrosis, Subcervical Hypertrophy	1

BLADDER MUSCLE

Inflammation	4
Fibrosis	8
Hypertrophy	16
No Hypertrophy	1

PROSTATE

Inflammation without fibrosis	12
Fibrosis	16
Concretions without inflammation	2
Concretions with inflammation or fibrosis	6
Muscle Hypertrophy alone or with inflammatory lesions	3
Gland and Muscle Hypertrophy alone or with other lesions	22
Suppuration	2

The above catalogue of lesions may be more briefly summarized as inflammatory and hypertrophic. The inflammatory lesions of the bladder neck lead ultimately to scar, while superficial ulceration or inflammatory retention cysts or vegetations may appear on the surface, and the "subcervical or middle lobe" hypertrophy may show any of the lesions characterizing a similar process in the true prostate lying outside the bladder muscle. Inflammation and fibrosis penetrate the region of the bladder sphincter either from the mucosa within or the prostate without. The hypertrophy of the bladder muscle is regarded as a secondary compensatory phenomenon tending, if anything, to minimize retention of urine. This hypertrophy is almost always found. For this reason the one exceptional case that showed no muscle hypertrophy seemed worthy of note.

In the prostate itself we find inflammation acute (miliary abscesses) or chronic with ensuing fibrosis. Concretions appear in these not-very-much-enlarged prostates sometimes associated with inflammation, sometimes without it, just as one finds them in the larger prostates. Muscle hypertrophy without gland hypertrophy is an unexplained and relatively rare pathologic finding. This, like the gland and muscle hypertrophy found in these slightly enlarged

prostates, is not to be distinguished from that of the truly large hypertrophies. Indeed the massive interstitial (muscle) hypertrophy of the prostate with pseudo-myomata which seems so characteristic of the very large hypertrophies is found equally marked in these small ones.

The gross pathologic character of this class of cases, so difficult to define, has been termed "dysectasia" by Legueu—rigidity of the bladder neck, to distinguish it from the obstruction due to plugging of the urethra by lobar obstruction. We habitually think of it as stricture, as though it threatened complete closure of the bladder neck, which, of course, it does not (except after trauma). Rather it should be thought of as resistance to opening of the bladder neck, loss of flexibility, whether due to inflammation or to hypertrophy; *i.e.*, dysectasia.

COMPARISON OF CLINICAL AND PATHOLOGIC DATA

It has been constantly noted that a precise pathologic pre-operative diagnosis of the inflammatory and hypertrophic conditions about the prostate and bladder neck may be attempted with only a very modest prospect of success. By combining rectal, cystoscopic and urethroscopic examinations (perhaps assisted by urethrograms) the outline of the prostate may be measured with a certain degree of accuracy. One should never miss roughly measuring the distance to which a catheter has to be introduced after passing the cut-off muscle before it draws water. One should use the cystoscope as an examining finger to palpate the obstacle at the neck of the bladder raised by bar or scar, and by cystoscopy make an effort to estimate the thickness of the commissural or middle lobe bar as compared with the relatively thin edge of the tight sclerotic bladder neck. The urethroscope should gauge deformities of the posterior urethra due to various lobar intrusions.

But when operation is reached the conditions found are often not precisely those that had been expected. Some bladder necks will grasp a No. 30 F. sound. These are sclerotic. Others though equally rigid will admit the finger readily and the finger in the posterior urethra will often gain a different and a much more precise definition of the size of lateral lobes projecting within the urethra than was had by the urethroscope.

We have not been able to follow the reasoning of Doctors Hyams and Kramer,[1] who seem to distinguish the inflammatory "pre-

fibrotic" conditions about the deep urethra from the fibrotic. Pathologically these conditions are allied. Fibrosis is not often found without some persisting round cell inflammation. Clinically we have found it quite impossible to distinguish a dysectasia of the bladder neck due to what the microscope will declare chronic inflammation from one which the microscope will label fibrosis. Doctor Hyams and Kramer seem to fear operation upon the "prefibrotic" lesions. Case 1 illustrates the fact that our inability to make distinction does not seem to have influenced our results. Perhaps these others were referring exclusively to the McCarthy operation, of which we have performed so small a number that we are unable to conclude anything more than this—that following the McCarthy operation some patients do indeed go through a prolonged period of bladder irritation quite disproportionate to the brief period of hospitalization and quite disconcerting to one who is accustomed to expect a prostatic patient to urinate comfortably after he leaves the hospital. It is not clear to us, however, that these spasmodic and inflammatory reactions that follow the modern high frequency cauterization of prostatic obstructions are attributable to inflammatory conditions existing before operation. We are rather inclined to attribute them to inflammation resulting from the operation itself.

However this may be, it is discouraging to operate suprapubically upon a bladder neck and prostate that seem thoroughly adherent and sclerotic, and have the pathologic report deny sclerosis of the prostate and confirm inflammation as in the following case.

Case 1.—Dr. G., first consulted me in 1902 at the age of thirty-six, having just had a perineal section for a stricture which had been irregularly dilated by sounds for twenty years and had finally become unmanageable. A No. 28 F. sound was passed without encountering any obstruction and he was faithful in returning every six months for dilatation. Yet in October, 1904, the stricture had again recontracted after a six months' interval and dilatation had to be carried from No. 11 F. up. At this time the urine was dilute, purulent and contained enough albumin to show a nitric acid ring. A few treatments cleared the urine of pus and the urethra of the stricture. But the following year after a ten months interval he had to be dilated from filiform. At this time it was found that hexamethylenamine kept this urine free from pus and bacteria which recurred if he stopped using it.

Subsequently the patient passed No. 25 and No. 27 F. sounds upon

himself from 1905 to 1927. After the passage of these sounds in July, 1927, he developed pyuria, frequent and painful urination and when a catheter was passed about 400 c.c. of urine was obtained. Thereafter he passed a catheter three times a day, keeping himself fairly comfortable, but returned to me in September, when the cystoscope showed much thickening and inflammation about the base of the bladder, and palpation on the cystoscope disclosed a thickening above the prostate which was interpreted as possibly carcinomatous. A second cystoscopy two weeks later showed that this supposed tumor had disappeared. This time, though the urine was foul smelling with pus and bacteria, its concentration was good, averaging about 1.014-1.018. Under bladder irrigations of silver nitrate he was ready in six weeks for operation.

The vasa were tied off, the bladder opened and a tight bladder neck with two slightly enlarged intraurethral lobes palpated. The whole was so adherent that it was impossible to enucleate anything. With the rongeur forceps several bites were taken from the floor of the bladder neck and then the little projecting lateral lobes were gnawed away.

Eight weeks after operation the patient visited the office for the first time. The urine was still thick with pus but residual urine was only 120 c.c. The suprapubic wound healed. He occasionally lost a few drops of urine between urinations. On bladder irrigation with silver nitrate the urine cleared up, the residual being recorded at various times between 25 c.c. and 125 c.c., usually about 50 c.c.

Six months after operation the patient was able to hold his urine all night and was entirely comfortable excepting that he leaked a little at sneezing. He then disappeared until January, 1932, when he returned with a history of having had no local treatment. He had a cataract in his right eye, was mentally and physically sluggish, dragging his feet. The diagnosis of general arteriosclerosis had been made. He was now getting up once at night to urinate and passing his urine every four hours by day. It was purulent, the specific gravity 1.012, albumin a trace. Residual urine varied from nothing to 100 c.c. Kollman dilator. After a month he could empty his bladder.

The specimen of prostatic tissue showed muscular hyperplasia but no hyperplasia of the gland tissue and everywhere round cell infiltration.

This, therefore, was pathologically inflammation, clinically fibrosis of the prostate distinguishable from fibrosis of the bladder neck by the fact that the bladder neck, though undistensible when examined through a suprapubic opening, was not very tight, and a large share of the obstruction was attributable to the intraurethral lateral lobes which showed no gland hypertrophy and only the lesions of inflammation and muscle hypertrophy. A prefibrotic prostate (and bladder neck

doubtless) combining with a rigid bladder neck to cause retention of urine.

Needless to say, the retention of urine does not measure the anatomical changes at the bladder neck. It is equally true that the patient's symptoms do not measure the amount of residual urine or the rigidity of the bladder neck nor is it wholly satisfactory to attribute the clinical picture of marked irritation with slight obstruction to a patient's nervous reactions. The discrepancy between symptoms and pathology is illustrated in all types of the prostatic obstruction. We have, for example, recently been consulted by a patient who for more than a year had been urinating from three to six times at night and occasionally exhibiting an initial hematuria. The urethra was short, the urine uninfected, the residual 75 c.c., the lateral lobes considerably enlarged as felt by rectum. Gentle passage of a No. 24 F. sound resulted in entire relief of symptoms. For three nights in succession he slept eight hours without urinating; the fourth night he urinated twice. A sound was passed again and for a week he was able to hold his urine at least six hours every night. A sound was passed a third time and the patient encouraged to hope that he might look for at least several months' respite. But this prophecy proved unwarranted. Chills and fever ensued, pus appeared in the urine, nocturnal frequency of urination recurred and extended into the day. Suprapubic prostatectomy successfully delivered a bilateral prostatic enlargement of considerable size. This is a familiar enough example of the influence of prostatic congestion upon the symptoms and illustrates the imperceptible difference between that instrumentation which will relieve congestion and that which will excite an acute outbreak of infection already existing within the prostate and which is usually erroneously attributed to the introduction of infection on an instrument rather than to the lack of dexterity in instrumentation.

A large number of the patients with prostatic bar or fibrosis exhibit lesser degrees of retention and until we had become familiar with the intra-urethral operations whereby these patients' symptoms can usually be controlled, such cases were the bane of the urologist. They could not be relieved without operation and the scar following prostatectomy often left the victim fully as uncomfortable as he had been before operation. Most difficult

TABLE I. BLADDER NECK INFLAMMATION OR FIBROSIS

Name	Age at Onset	Age at Operation	C.C. Residuum	Prostate: By rectum	Prostate: By Cystoscope	Operation	Pathology: Bladder Neck	Pathology: Muscle	Pathology: Prostate	Results
M. C.	60	60	C*	Normal	Bar	C	Inflammation, fibrosis, ulcer, polyp	Hypertrophy, fibrosis	.....	Cured 6 mos.
C. D.	31	44	C	Small	Cannot enter	R	Ulcer, polyp, inflammation	Hypertrophy	Suppuration, muscle hypertrophy	Gained 35 lbs. Cured 4 yrs. Lues; neg. spinal fluid
Ke.	50	51	C	Small	Obstruction at bladder neck	Y	Inflammation	Inflammation	Inflammation	Well 7 yrs., urine purulent, gained 21 lbs.
R.	45	45	C	Small	Median bar	C	Inflammation, ulcer	Hypertrophy	.....	Cured 6 mos.
W. A.	40	45	C	X2	.....	R	Inflammation, fibrosis, polyp	.....	.....	Relieved†
Ma.	56	60		.....	Bar	C	Inflammation, fibrosis, ulcer	.....	.....	Discharged improved
DeM.	51	54	C	Small	Bar		Fibrosis	.....	.....	Discharged improved
Ann.	64	66	C	Small	Bar	R	Inflammation, ulcer, polyp	Hypertrophy	Inflammation	Improved, 2 yrs. (Diabetes)
Schw.	56	56	150	.....	Bar, ulcer	R	Ulcer, fibrosis	.....	.....	Relieved†

*Using catheter or over 500 c.c. residuum
C = Caulk
R = Fuller suprapubic rongeur
Y = Young punch
† = Well when last seen. Followed less than 6 months

of all to manage have been those patients who introduced what seemed a neurotic element into the clinical picture. Case 2 exemplifies these.

Case 2.—C. A., fifty-five years of age, came on June 10, 1929, complaining of frequent and slow urination for fifteen years. He was a lean, Irish subway ticket chopper six feet one in height and weighing 180 pounds. He was mentally not brilliant and was deeply impressed by the many years of difficult and frequent urination which had been unrelieved by various treatments. He urinated every two to four hours by day and was up only once at night. He was constipated. He thought he was becoming impotent. His habits were good—one cup of tea a day, no coffee, moderate smoker, moderate ingestion of sugar and rarely of alcohol. He had suffered from hay fever all his life. The urine showed no pus, no albumin, no sugar; its specific gravity was 1.010-1.014. No constriction was detected in his urethra. The residual urine on numerous examinations was constant but varied from 25 to 50 c.c. Prostate was a shade large by rectum. The urethroscope showed no bar. The cystoscope detected a small intraurethral middle lobe. Various local and general treatments failed to relieve the symptoms. After four months of this a Caulk cautery punch was performed. He was home in four days without complications though since the operation the urine contained pus and a faint trace of albumin. The residual urine was lessened, frequently none was obtained and as a rule about 25 c.c. But the symptoms remained about the same. The actual difficulty in urination was at times worse and if the weather was cold or he exercised, the diurnal frequency became once every hour or two. For a number of months, by September, 1930, after a good deal of prostatic massage and other local treatments, frequency was about the same as when we first saw him. Meanwhile erections had disappeared entirely. In December, 1930, a review of his condition showed the prostate slightly larger than before; cystoscopy negative. The urethroscope showed a lengthening of the urethral slit, a slight protrusion of the right lateral lobe and a nubbin of urethral bar to the left.

In September, 1931, the diurnal frequency had again reached once every hour, the dysuria was considerable, the prostate felt less large by rectum.

The bladder was opened suprapubically and a dense "horse collar" prostatic enlargement was found with very slight intraurethral lateral enlargement and no middle lobe. With counter pressure in the rectum the "horse collar" was bitten away by the rongeur under direct observation and the lateral lobes then readily enucleated. (Enucleation of the "horse collar" would have been impossible; it was too dense.) In the course of operation a few prostatic calculi were found.

Pathologic report was inflammation and ulceration of the bladder

TABLE II. PROSTATIC BAR AND MIDDLE LOBE

Name	Age at Onset	Age at Operation	C.C. Residuum	Prostate		Operation	Pathology			Results
				By rectum	By Cystoscope		Bladder Neck	Muscle	Prostate	
E. B.	49	50	25	Normal	Bar	R	Inflammation, fibrosis	.....	Fibrosis, gland hypertrophy	Cured 7 yrs.
G. H.	19	22	50	Normal	Bar	R	Inflammation, (ulcer of bladder)	Inflammation, hypertrophy	Gland hypertrophy	Cured 4 yrs. (Elusive ulcer of bladder.) Recurrence relieved by dilatation at 2 yrs.
Ly.	51	51	50	Normal	Bar	R	Inflammation, ulcer	.....	Concretions, gland hypertrophy	Relieved
J. R.	43	61	25	Normal	Bar	C	Inflammation, ulcer	Hypertrophy	Edema, gland hypertrophy	Relieved 1 mo.
Sw.	66	67	C†	Small	Bar	R	.....	.....	Inflammation, gland hypertrophy	Died in 3 days of uremia
St.*	57	65	C†	Normal	.....	R*	.....	Hypertrophy	Suppuration, inflammation, gland hypertrophy	4 mos. relieved

Sp.	67	70	500	Normal	Bar, diverticulum	RC	Inflammation	.....	Inflammation, gland hypertrophy, concretions	Improved, 4 mos.
Ha.	63	64	0–200	Normal	Bar	C	Inflammation, ulcer	Fibrosis	Inflammation, concretions, fibrosis, gland hypertrophy	Improved
Pea.	67	67	C†	.....	.....	R	.....	.....	Inflammation, fibrosis, gland hypertrophy	Retention due to resection of rectum for carcinoma Cured 5 yrs.
Kni.	54	64	100	Small	Bar	C	Inflammation, fibrosis, ulcer, gland hypertrophy	Hypertrophy	.....	Cured 2 yrs.
Dr. A.	55	56	C†	Small	.....	RE	Inflammation, fibrosis, gland hypertrophy	Hypertrophy	Inflammation, gland hypertrophy	Cured 6 yrs. (Small middle lobe)
Ben.	Yrs.	72	C†	Normal	Middle lobe	C E	Inflammation, fibrosis, gland hypertrophy	.....	Gland hypertrophy (2nd operation)	Clinically small middle lobe Cured 4 yrs.

†Using catheter or over 500 c.c. residuum
*Diverticulectomy
R = Fuller suprapubic rongeur
C† = Caulk punch
RC = Fuller suprapubic rongeur + Caulk
RE = Rongeur and prostatectomy
CE = Caulk and prostatectomy
E = Prostatectomy

TABLE III. PROSTATIC FIBROSIS

				Prostate			Pathology			
Name	Age at Onset	Age at Operation	C.C. Residuum	By rectum	By Cystoscope	Operation	Bladder Neck	Muscle	Prostate	Results
Ag.	40	40	100	X2	Bar rt. lobe	C	.....	hypertrophy	fibrosis	Cured 18 mos.
FHan	45	48	C†	Small	Bar rt. lobe	C	Inflammation, ulcer	inflammation not hypertrophy	inflammation, fibrosis	Relieved
Br.	50	55	30–200	Normal	Bar	C*	Inflammation	hypertrophy	fibrosis	Cured 3 yrs.
Ab.	Yrs.	74	30	Normal	Bar	C*	.....	.....	inflammation fibrosis	Cured 1 yr.
Min.	41	41	+	Small	Bar	R	.....	.....	inflammation, fibrosis, glands destroyed	Relieved
Ca.	40	55	50	Small	Intraurethral Median lobe	C	Inflammation, ulcer	hypertrophy	inflammation, fibrosis, glands destroyed	Retention relieved Symptoms unimproved.
		57		X2	Normal	RE	.....	.....	concretions	Relieved. See text.

HGoo	60	61	C†	Adenoma	.....	RE	.....	.....	gland atrophy, muscular hypertrophy. Intraurethral rt. lobe	Cured 1 yr.
Whe	51	54	15–30	Normal	Bar	McC	Inflammation, fibrosis, ulcer	inflammation fibrosis	inflammation, fibrosis, muscle hypertrophy	Later suprapubic drainage for hemorrhage. Relieved
FCla	73	75	50–100	Normal	Lateral lobes	McC	inflammation, ulcer	.....	concretions, inflammation, fibrosis, atrophy	Cured 4 mos.
Kr.	55	65	25–100	Scar	Bar	McC	.....	hypertrophy, fibrosis, no inflammation	inflammation, fibrosis	Recovered
Az.	45	60	50–75	Scar	Bar	RE	.....	.....	inflammation, gland hypertrophy, concretions, panarteritis suggesting syphilis	Relieved by suture of suprapubic fistula Well 4 mos.

*Diverticulectomy
C = Caulk punch
McC = McCarthy operation
CE = Caulk and prostatectomy
†Using catheter or over 500 c.c. residuum
R = Fuller suprapubic rongeur
RE = Rongeur and prostatectomy

TABLE IV. LATERAL LOBE OR GENERAL ENLARGEMENT

Name	Age at Onset	Age at Operation	C.C. Residual	Prostate: By rectum	Prostate: By cysto.	Operation	Pathology: Bladder Neck	Pathology: Muscle	Pathology: Prostate	Results
J. H.	58	60	C†	X2	Bar	C	inflammation, gland hypertrophy	inflammation, fibrosis	inflammation, fibrosis	Cured 2 yrs.
	....	63	C†	X3	Stone	RE	inflammation, fibrosis	.....	gland hyper., inflammation	Cured 3 yrs.
	....	67	C†	X3	Irreg. neck (ca)	McC	.....	.....	carcinoma	Relieved
McE.	58	68	30	Small	Small lateral lobes	Col RE	inflammation, fibrosis, ulcer	.....	inflammation, fibrosis, gland hyper.	Unimproved 4 yrs. (4 mos. between operations)
Cre.	65	70	C†	Flat Broad	.....	RE	.....	.....	Concretions, gl. hyper. (ca?)	Relieved
VonN.	64	67		X2	.....	RE	.....	.....	inflammation, gland hyper.	Relieved
Row.	47	50	C†	X2	.....	R	inflammation, fibrosis	hypertrophy	gland hyper.	Relieved
P. Q.	65	70	C†	X3	Bar	R	.....	inflammation, fibrosis	inflammation, fibrosis	Did not heal
						C	.....	.....	gland hyper.	Relieved
Ga.	66	66	C†	X2	.....	RE	inflammation, fibrosis, ulcer	.....	inflammation, gland hyper., gl. destroyed by scar	Relieved
HI.	46	46	C†	....	sl. lateral and middle lobes	RE	inflammation, edema, ulcer, cysts	hypertrophy	.....	Relieved
Al.	73	73	500	X2	Bar	C	.....	.....	inflammation, gland hyper.	Relief 1.5 yr. then suprapubic prostatectomy; cured.

†Using catheter or over 500 c.c. residuum
C = Caulk
Col = Collings
McC = McCarthy
R = Fuller suprapubic rongeur
RE = Rongeur and prostatectomy

†Using catheter or over 500 c.c. residuum
C = Caulk
Col = Collings
McC = McCarthy
R = Fuller suprapubic rongeur
RE = Rongeur and prostatectomy

TABLE V. STONE AND BAR

			Prostate					Pathology			
Name	Age at Onset	Age at Operation	C.C. Residuum	By rectum	By cysto.	Operation	Type of Obstruction	Bladder Neck	Muscle	Prostate	Results
Du.	59	63	?	.....	Bar, stone, cyst	LC	fibrosis of bladder neck	inflammation, fibrosis, atrophy	inflammation, fibrosis	.....	2 previous litholapaxies Cured 3 yrs.
New.	yrs.	65	100	Normal	Bar, stone	LC	inflammation of bladder neck	acute suppuration, edema	acute inflammation, edema	.....	Cured 3 yrs.
Fil.	52	55	400	.....	Bar, stone	R	inflammation of bladder neck	inflammation	inflammation, hypertrophy, fibrosis	.....	Relieved
Rev. St.	69	79	200	X2	Bar	LC	prostatic bar	.....	hypertrophy	gland hypertrophy	Cured 1 yr.
Cl.	66	72	?	Sl. enlargement	Bar, slight lateral lobes	RE	fibrosis of bladder neck	inflammation, fibrosis	.....	no hypertrophy, inflammation corpora amylacea	Relieved

LC = Litholapaxy and Caulk punch
R = Lithotomy and Rongeur
RE = Lithotomy and Prostatectomy and Rongeur

TABLE VI. URETHRAL STRICTURE—PROSTATIC RETENTION

	Patient's age at					Prostate			Pathology				
Name	Stricture	Urethrotomy	Partial retention	Prostatic Operation	C.C. Residuum	By rectum	By cysto.	Operation	Type of Obstruction	Bladder Neck	Bladder muscle	Prostate	Results
Dea.	33			50		.....	Bar	C	inflammation of bladder neck	inflammation	hypertrophy	inflammation	Cured 4 yrs. Gained 35 lbs.
Dr. G.		37	61	62	C	.....	.....	RE	?	(see text)	.....	inflammation, muscle hypertrophy	5 yrs. later residual 100 c.c. relieved by dilatation. Has had hemiplegia. Senile.
Fie.			67	67	C	Normal	.....	RE	lateral hypertrophy	inflammation, fibrosis, ulcer	hypertrophy	gland hypertrophy, concretions, inflammation, edema	Relieved.
Dent	53		56	61		Normal	Bar	RE	lateral hypertrophy	acute inflammation, ulcer	.....	suppuration, gland hypertrophy, concretions	Cured 6 yrs.
Qua.		53		68	25-100	X2	Not cysto.	RE	lateral hypertrophy	inflammation	.....	gland hypertrophy	Cured 1 yr.

C = Caulk punch
RE = Prostatectomy and Rongeur

neck, hypertrophy of the bladder muscle; inflammation, fibrosis and gland destruction without hypertrophy of the prostate.

The patient left the hospital healed on the fifteenth day and since that time has had no dysuria. His urination is comfortable but still frequent. No residual urine. If he drinks much water or the weather is cold he still has frequent passage of dilute urine. But when last seen in August, 1932, he was reassured and happy at relief from the sense of obstruction, and the frequency of urination was tending to be less.

This is a borderline case. One cannot prove that the prostatectomy helped this patient. He thinks it did. Such cases, while illustrating the dependence of the patient's symptoms upon other than purely pathologic causes, are not meant to encourage operation upon patients whose symptoms may be relieved by prostatic massage, dilatation of the posterior urethra and other local measures.

It has seemed convenient to classify the cases considered in this paper under the following titles:

Table I.—Bladder Neck Inflammation or Fibrosis—including those cases that on pathologic examination do not show any prostatic gland hypertrophy or fibrosis with the exception of those included in Tables V, VI, and VII. One prostate felt slightly large by rectum. This was attributed to inflammation.

Table II.—Prostatic Bar and Middle Lobe—including cases which show no enlargement of the lateral lobes of the prostate but do show commissural or subcervical hypertrophy whether associated with inflammatory or fibrotic lesions or not.

Table III.—Prostatic Fibrosis—including cases of prostatic fibrosis without gland hypertrophy whether intraurethral, lateral or middle lobes were found at operation or not.

Table IV.—Lateral Lobe or General Enlargement—including the lateral lobe hypertrophies, only two of which showed by cystoscope, the others being intraurethral. One of these happens to cover the whole picture of prostatic retention. The patient was relieved at the age of sixty for two years by a Caulk punch. Tissue removed showed fibrosis with a trifling middle lobe hypertrophy. When symptoms recurred a suprapubic rongeur was required to attack the bladder neck while enucleation removed fair sized hypertrophied lateral lobes. After relief lasting for three years the pa-

TABLE VII. POST-PROSTATECTOMY FIBROSIS

Name	Interval since Prostatectomy	Age at Operation	C.C. Residuum	Prostate: By rectum	Prostate: By cysto.	Operation	Pathology: Bladder Neck	Pathology: Muscle	Pathology: Prostate	Results
Kno.*	4y	70	+	.....	stone	LY	inflammation, fibrosis, ulceration	.....	no hypertrophy	Relieved. Died 1 yr. later, cause unknown
Kra.	1y	49	fistula	small	.....	CR	.....	hypertrophy	inflammation, rare gland hypertrophy	Relieved 4 yrs., but 100 to 150 c.c. residuum
Bea.*	18m	63	fistula	normal	.....	RE	inflammation, ulcer	.....	inflammation, gland hypertrophy	Relieved
McC.	2m	60	fistula	.....	.....	R	.....	.....	suppuration, fibrosis, gland atrophy	Cured 4 yrs. (probably a sclerotic prostate originally)
E.	5w	59	fistula	X2	middle lobe	C	inflammation, ulcer	.....	inflammation	Cured 1 yr.

*Stone
LY = Litholapaxy and Young punch
C = Caulk
R = Rongeur
E = Prostatectomy

tient returned with a carcinoma of the prostate, the symptoms of which have been temporarily relieved by a McCarthy operation.

Tables V and VI.—Including those cases in which the prostatic retention has been characterized by no great enlargement of the gland and associated with stone (Table V) or urethral stricture (Table VI).

Table VII.—Finally, this table is introduced to make the picture complete, exhibiting the pathologic findings about the bladder neck and prostate of those patients whose retention had not been relieved by preceding suprapubic prostatectomy.

Speculation as to the age groups at which these various inflammatory and hypertrophic lesions occur cannot be based upon these tables. The number of cases is too small and the figures too confusing.

COMMENT

Actually, the examining finger at the time of suprapubic cystotomy is the best gauge of the mechanical type of obstruction. The sclerotic or inflammatory bladder neck, for example, will tear to admit the examining finger into the posterior urethra where slightly enlarged lateral lobes may or may not be encountered. In other instances the less inflamed bladder neck opens to admit the finger and the enlarged lobes within the urethra are the chief source of obstruction. When these have been enucleated, the examining finger recognizes that the sphincter has become relaxed and the bar between the lateral lobes, which had been raised up as an obstruction by their presence, has now been lowered (unless there is commissural hypertrophy) and does not require attention.

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AN EXPERIMENTAL RESEARCH BY PARABIOSIS, SHOWING THE HYPOPHYSEAL-GONADAL INFLUENCE ON THE GROWTH AND DEVELOPMENT OF THE PROSTATE GLAND*

WM. E. LOWER, M.D., and N. F. HICKEN, M.D. (by invitation)

Cleveland, Ohio

At the annual meeting of the American Urological Association, in Memphis, Tenn., May, 1931, I presented a paper on "Further Studies on Experimental Work on Probable Causes of Prostatic Hypertrophy." This was published by Dr. R. L. Johnston and myself in The Journal of Urology for November, 1931. In this communication we called attention to the fact that the influence of the secretion of the hypophysis on the testes controls the function and development of the secondary sex organs, the prostate, seminal vesicles, et cetera; that in castrated, mature animals the prostate atrophies; and that in castrated, young animals it fails to develop. However, if male sex hormone is injected, atrophy does not occur and the development of the prostate in young animals proceeds.

In order to eliminate any factors which might be present in the chemical extraction of the hormone and its transfer into a normal animal, we decided to check this by the elimination of any extraneous factor, and a series of experiments was carried out by parabiosis.

This anatomic union between two animals was effected by making a lateral skin incision on opposite sides of each animal from the hip to the shoulder, and each abdominal cavity was opened from the diaphragm to the pelvic girdle. The muscular walls and peritoneum were anastomosed in such a manner as to leave a permanent artificial opening connecting the two peritoneal cavities. This artificial stoma permits a free exchange of peritoneal fluids, and the intestines of one animal may pass into the peritoneal cavity of its partner. In eighty-seven pairs of such twins the opening

*Collaborating in this research were Dr. D. R. McCullagh and Kenneth Cuyler. The work was done under the George W. Belcher Fellowship in Experimental Urology, a gift of Roger C. Hyatt, Esq.

has remained patent in all but one case, the average diameter of the stoma, measured at the time of autopsy, being 2.5 cm.

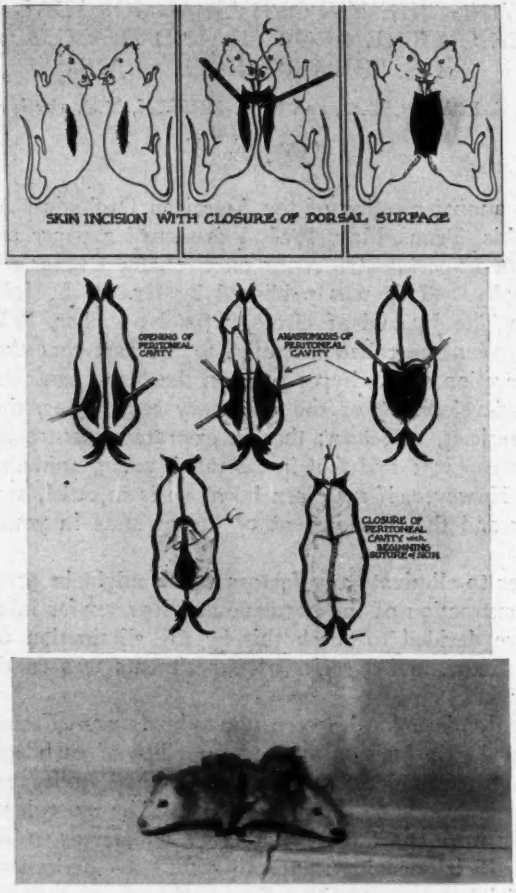
SKIN INCISION WITH CLOSURE OF DORSAL SURFACE
OPENING OF PERITONEAL CAVITY
ANASTOMOSIS OF PERITONEAL CAVITY
CLOSURE OF PERITONEAL CAVITY with INCORPORATING SUTURE of SKIN

Fig. 1. Technic of parabiosis.

These pseudo-Siamese twins live together in perfect harmony without any disturbance in their normal physiologic function. If two adult females are joined together, both animals have regular

estrogenic cycles. If two adult females are twinned just after impregnation, they have a normal period of gestation and give birth to healthy young. If this parabiotic union disturbed the functions of the reproductive organs, one might expect the pregnant subjects to abort, but such was not our experience. Seven pairs of normal male

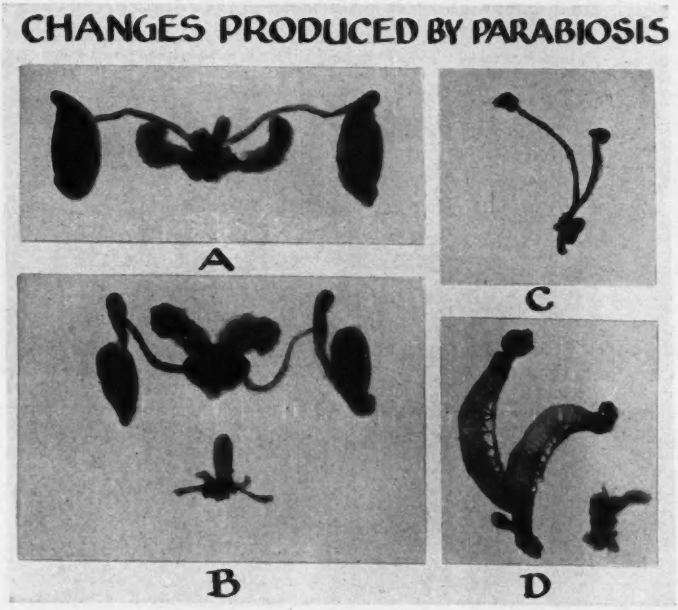

Fig. 2. (A), genital tract of one of two normal rats in parabiotic union. Compare with (B), the genital organs of a normal male in union with a castrate whose organs are also shown. (C), genital tract of one of two normal females in parabiosis. Compare with (D), where a normal female was in union with a castrated male. The organs of the castrate are also shown.

rats were joined together, and the animals were sacrificed at various intervals from one to eight weeks after this junction. There was no change in size, weight or microscopic appearance of the hypophysis, testes or prostate gland when compared with single controls. Hence parabiosis does not alter the normal function of the sex organs. The parabiotic experiment was proposed because

of the assumption that there is an exchange of hormones and secretions between the two partners. This could occur by means of collateral circulation at the site of anastomosis, or by intestinal absorption of the secretions from the peritoneal fluids. Methylene blue was injected into the jugular vein of one animal, but could

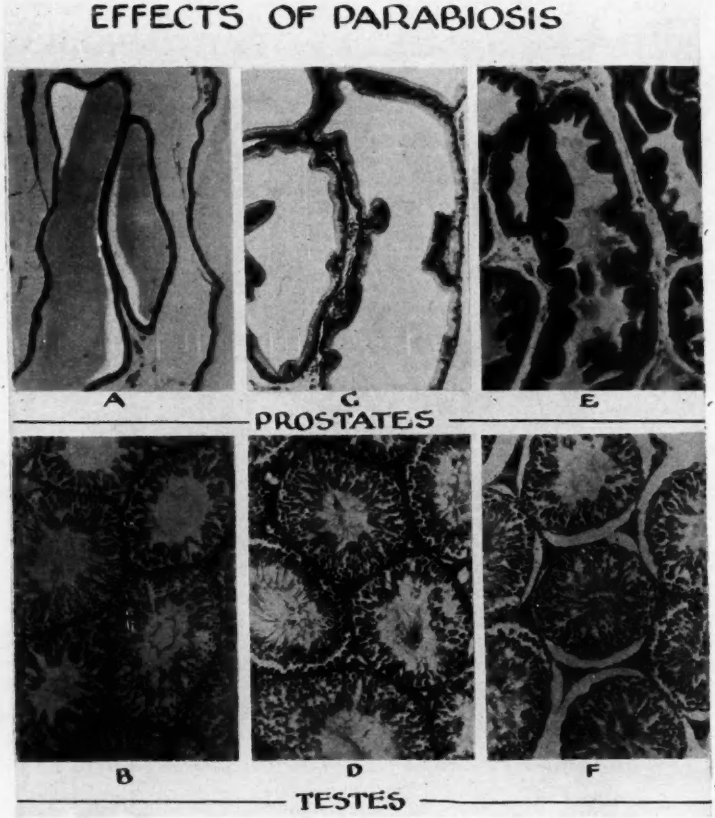

Fig. 3. (A) and (B), one of two normal rats in parabiotic union; (C) and (D), normal rat of a normal-castrate union; (E) and (F), untreated partner of two normal rats in parabiotic union, one of which was injected with Antuitrin "S" (P. D. & Co.). Untreated parabiotic rats present apparently normal prostate (A). Hyperfunction of the hypophysis as caused by castration or injection of Antuitrin "S" produces epithelial proliferation and hypertrophy of the prostate, (C) and (E).

not be detected in its mate. This finding precluded the possibility of a vascular anastomosis. Three cubic centimeters of 50 per cent solution of glucose was injected into the femoral vein of one animal and in two minutes hyperglycemia was produced in its partner. The glucose, which is highly diffusable, apparently had passed from the blood stream of the injected rat into its peritoneal fluid and was absorbed by the intestine of the opposite animal. This demonstrates that there is a physiologic transmission of secretions between parabiotic mates.

Castrated male rats were twinned with normal males. The prostate and seminal vesicles of the castrate became small and atrophic, and the pituitary gland increased in size. In the normal partner the testes, prostate and seminal vesicles were hypertrophied, but the pituitary remained normal. When the rats were permitted to live for thirty days, the prostate of the normal animal was increased both in size and weight from 300 to 500 per cent. The gland was very firm and solid and had a preponderance of glandular tissue, and the enlargement was uniform. It required ten days for any changes to become evident, but from then on the hyperplasia was very rapid.

After ablation of the gonads in the castrated male, the hypophysis is increased in size and function. The excessive pre-hypophyseal hormone passed from the castrated animal over into its normal partner and caused the testes to secrete an excess of the sex hormone which resulted in hypertrophy of the prostate. That the hypophysis of a castrated male is hyperfunctioning can be demonstrated by twinning a castrate with a normal female. The pituitary secretion passed into the female, stimulated the ovaries and produced a protracted estrous cycle and enormous enlargement of the horns of the uterus and the vagina. Similar results were obtained by injecting anterior pituitary extract directly into a normal female.

Thus, by merely altering the endocrine system, by causing hyperfunction of the pituitary gland and permitting the hormone to pass into a normal rat, prostatic enlargement has been produced. A control of this regulatory mechanism of the influence of the hypophysis upon the sex glands may furnish the solution for the prostatic problem.

PROPHYLAXIS OF PROSTATISM

JOSEPH F. McCARTHY, M.D.

From the Department of Urology, New York Post Graduate Medical School, Columbia University, New York City

While the inevitable conflict of divergent opinions is waging, as how best to manage the obstructive manifestations of the senile prostate, it seemed to the writer appropriate to present for your consideration, between rounds, as it were, the much more important phase of the subject—Prevention.

This communication will elaborate, therefore, certain concepts concerning the mechanism of this type of urinary obstruction as well as the method herewith advocated for their alleviation and correction.

Various theories have been advanced as to the physiology of micturition, as well as the disturbance occasioned the finely coordinated neuro-muscular mechanism by the encroaching prostate or inflammatory fibrosis, with their resultant urinary retention. This, in the final analysis, is the forerunner of the well known train of pathologic conditions incidental thereto.

While these are matters of vital importance they are too involved and academic for detailed description in this paper. They have, however, impelled us to give closer attention to this phase of the subject, and from our pre-operative studies, the following impressions are presented for discussion.

The theory most acceptable to the writer as to the physiology of the normal act of micturition is the one suggested by Young, who claims that this act is effected chiefly by a downward pull at or near the floor of the sphincter. This can be verified by endoscopic observation, and is supplemented from above by combined pressure of the bladder wall and abdominal muscles, with the final propulsive action of the accelerator muscles.

In support of this conception may be advanced two well known facts: (1) That a very considerable degree of urinary retention may ensue from a moderate amount of fibrosis or glandular hyperplasia situated in this region; (2) that the removal of this tissue,

with the formation of a trough or gutter, is almost invariably attended by complete symptomatic relief.

There appear to be three main types of obstructions in the mechanism of prostatic urinary retention. The first is gradual in onset, is constantly cumulative and but occasionally reaches the stage of acute retention. The underlying causative factor here is pathologic intrusion at the floor of the sphincter. Under this heading may be mentioned vesical neck fibrosis, so-called collar prostate or middle lobe involvement.

The second is the spasmodic or intermittent form of retention which is characterized by rapidity of onset and frequently attended with complete, though usually temporary retention. This is the well known type wherein the patient reports satisfactory antecedent bladder function and experiences interval periods of well-being, with but nominal residual urine between attacks.

The bladder dysfunction in this type occurs usually after prolonged exposure to cold, as attendance at a football game, or any sustained excess. It is also the individual that impresses the superficial observer as having been cured by the passage of sounds, deep X-ray, et cetera. This is the pure lateral lobe, intra-urethral intrusion, which, contrary to some previously held beliefs, plays but an occasional rôle in urinary retentions.

The third is a combination of the first two and it is reasonable to infer that here, too, the lateral lobes are but an incidental factor. This assumption is confirmed by the observation that the removal of obstructing tissue involving the "water fall" at the floor of the sphincter is so frequently followed by symptomatic relief and good bladder function, even in cases where obvious lateral lobe intrusions have been left untouched.

For these reasons it would appear that proponents for the removal of a definite proportion of the prostate in accordance with its size, should support such contentions with convincing data. Time alone must determine how much or little should be removed by these methods. The business end of most prostatic obstructions or inflammatory fibrosis is the part that involves the floor of the internal sphincter or occasionally such as distorts or encroaches upon the lumen of the canal. Certainly the size of the prostate is of little value as a determining factor.

Operative experience in a fairly large series of cases, supple-

mented with careful visual postoperative study, has served to verify the early impression of this writer that an operation of canalization, to the extent of an exaggeration of the normal tubular conformation of the deep urethra, should suffice. This canalization which resembles a tunnel begins at the internal sphincter and ends at the posterior frenum of the verumontanum.

The logic of the procedure is:

1. It is an attempt at natural restoration, not an effort to beat nature.
2. It is time-conserving, minimal as to interference, with its compensatory lack of operative and postoperative complication.
3. It is a matter of common knowledge that deviation of the urinary stream by cystotomy, at least in the benign hypertrophies, is almost invariably followed by shrinkage of the organ.
4. In cadaver teaching, because of the very considerable postmortal diminution in its size, it is almost impossible satisfactorily to demonstrate the technical steps incidental to prostatectomy.
5. If insurance is to be had against a possible recurrence, no vestige of glandular or fibrotic tissue should be left remaining, and, according to the literature, even prostatectomy is not always proof against occasional recurrence.
6. Many observers have reported notable rescession in the size of the prostate, following the disappearance of the obstructive symptomatology of frequency, exaggerated micturitional effort, residual urine, etc.
7. Finally—any effort at an approximation of possible recurrence should include a knowledge of the number of years involved in the consummation of the hypertrophied prostate.

It would appear, therefore, that the enlarged prostate is an hydrated rather than an essentially hyperplastic organ; that because of the frequency of reported acute or chronic inflammatory change, and because of the pronounced variation in vascular characteristics, more scrutinizing methods of laboratory examinations of removed prostates and prostatic tissue should supplant the present loose and inconclusive reports.

In the past, few urologists have had the temerity to recommend surgical interference as a remedy for prostatic encroachments in their early manifestations, for were they to do so, the family physician, because of the major character of the operation, would have

been reluctant to recommend, and the patient, through apprehension, to accept such a step. Today, because of these technical advances, and, at this stage at least, the relative minor nature of the procedure, it seems to this writer that we are now in a position to advise the correction of these malformations before the onset of their inevitable debilitating sequelæ, and to have such advice accepted.

In preparation for such eventuality much thought should be given this subject to the end that a common ground be established, as to types indicating, extent of, and appropriate time for, such interference.

As a basis for such discussion it might be submitted that, in view of the fact that fibrosis is but a late manifestation of prostatic or peri-prostatic inflammation, the question may very well be asked: Are we not remiss in the treatment of such cases? Shall we interfere in the so-called pre-fibrotic stage of prostatic change? Should we not be in possession of more precise information as to the microscopic picture and the bacterial flora, that may be present in the prostatic secretion or in other remote foci, and may it not here be the part of wisdom to carry out even prolonged courses of preparatory treatment prior to any attempt at endoscopic revision?

Are we dealing with nocturia as opposed to polyuria? Here, of course, specific gravity, total intake and output, and the presence or absence of residual urine, must be carefully estimated. Shall we determine by urethrographic study the patulousness of the prostatic and ejaculation ducts as an evidence of the extent of the inflammatory involvement of these structures.

In the event revison is indicated, how much or how little of the prostate or bar should be removed? Shall any evidence of encroachment by the lateral lobes be obliterated?

Having in mind the probable evolution of the lateral lobe pathology, should all men fifty years of age or older with microscopic pus, in the absence of renal pathology, be endoscoped?

All the above, in addition to the question and the appropriateness of time for visual follow-up, come to mind.

If these and other phases of this multifaceted question are to be casually treated, the grievous errors of promiscuity and precipitancy, that have bedeviled this epoch-making departure in its application to establish prostatism, will be repeated.

In view of the fact that a communication on technic will be read next week at Toronto, this phase will be outlined here largely by lantern slides.

Suffice to state, the method here presented meets the most exacting technical requirements, is logical and rational, and in skilled hands the most efficient method advocated for the purpose.

CONCLUSION

When it is realized that approximately 25 per cent of the male element of the human race, in greater or lesser degree, suffer from this condition, the tremendous economic and sociologic importance of its prevention becomes at once apparent.

It is the conviction of this writer that precise methods for prevention are now available, that with dissemination of this knowledge, the restriction of the method to experienced urologic clinicians, and judicious case selection, oncoming generations need not be cognizant of the vicious cycle of prostatism.

DISCUSSION

Dr. E. G. Crabtree (Boston): The employment of new measures for the treatment of prostatism has accentuated the need for accuracy of diagnosis.

Dr. McCarthy has just shown urethrograms such as I have employed, both for pre-operative diagnosis and for postoperative results, for a period of three years.

It seems to me that urethrograms cannot be expected to produce

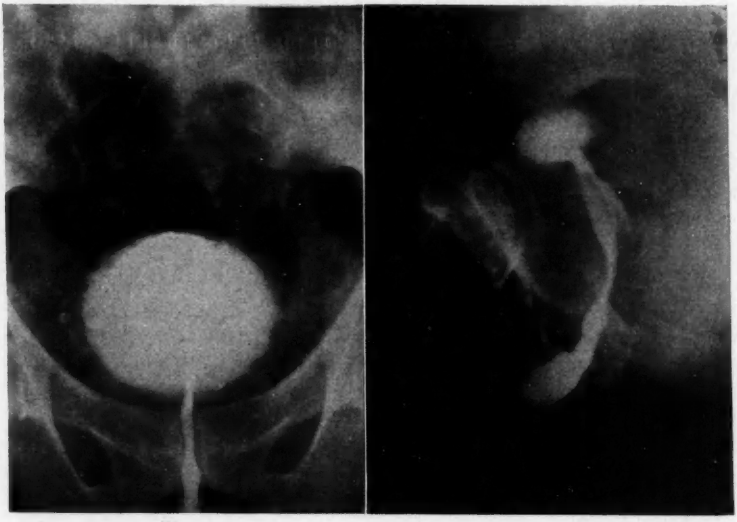

Fig. 1. Urethrograms of a case of benign hypertrophy of the prostate. Pre-operative films.

the whole diagnosis, but I am convinced that they are of some aid in the differentiation of the various types of obstruction. It is particularly useful in the study of postoperative results, in that it gives a yardstick for comparing the pre-operative and the post-operative pictures with the final remote result, either months or years later. It has seemed to me to be more than helpful as an

aid in determining the cause of failure to obtain relief in the less satisfactory cases.

It will be noted from the lantern slides, that I will present, that the different types of operations now in use do produce changes of different types in the prostatic urethra which, with a little experience, are readily recognized.

(Slide 1) This is the urethrogram of a normal young adult without either signs or symptoms of prostatic change.

(Slide 2) This urethrogram is the average result of a suprapubic enucleation of a fair-sized adenoma with persistence of the

Fig. 2. The same case as shown in Figure 1 after transurethral operation.

cavity, absence of evidence of the internal sphincter but with competent external sphincter. It is a case of good functional result.

(Slide 3) This is a case of fibrous bar in an atrophic type of gland in which the median bar indentation is easily recognized in the pre-operative urethrogram as well as the effect of Collings' median bar cautery operation is apparent in the postoperative urethrograms.

(Slide 4) The pre-operative urethrograms in anteroposterior and oblique views on the left side of the picture; on the right

side are shown the anterior and oblique views of the same case immediately after transurethral prostatotomy. The impingement of the lateral lobes can be noted in the urethrograms, previous to operation, which are absent in the postoperative urethrograms. At the time of operation an attempt to remove the lateral lobes in part was made.

(Slide 5) These urethrograms show the postoperative picture produced by total prostatectomy for the small fibrous gland.

DR. JOHN R. CAULK (St. Louis): One has scarcely the heart to discuss earthly affairs after sitting under the celestial brilliancy of Dr. Lower and his co-worker on that magnificent piece of work.

I am particularly gratified at the tendency of urologists to adopt transurethral resections, after my twelve years of insistence on the advantages of this type of procedure.

There are a few things which I wish to call briefly to your attention.

In the first place, we must recognize absolutely that this is not a child's play. It is a delicate surgical procedure attended by difficulties and dangers. It is highly technical and needs skill in pre-operation, during operation and in postoperation; there is no question about it. It requires much more skill than major surgery in the operative technic, and certainly in postoperative care.

I have done 781 cases, the majority of them with larger obstructions. Whether I have been justified in doing them or not remains to be seen. My results have been just as pleasing as I have ever had by prostatectomy, but I have worked much harder than I have in prostatectomy. I want to tell you, who have not tried it, that you can't just go in and bite off a few pieces and expect results.

I do believe this: that whether this prostatic enlargement is the result of some internal secretory deficiency or activity, or whether it is the result of inflammatory change of a slow, indolent process going on for a long time, the removal of a fair amount of tissue and draining the different parts of the prostate itself insures a rapid and sometimes astounding resolution or absorption on the part of the remaining prostate.

For this reason, I believe that we must be guarded, particularly the men who haven't tried this operation, in doing too extravagant resections. If nature does help us so materially in the absorption and resolution in this gland, let's allow nature to help us and don't

subject, particularly the older patient who is a bad risk anyway, to tremendous raw surface with poor drainage.

I, personally, would much prefer, if it were an extravagant resection, to do an open operation. I have done the operation on almost all prostates, chiefly to convince myself of the uniform tendency for the gland to resolve out of proportion to the amount of tissue removal. I am happy with the results.

I am not discussing the instrument. We have a principle here to deal with entirely, and not an instrument procedure. I know that with the punch I can remove as much as I want, and I can remove it in a short period of time. I do believe prolonged instrumentation is to be decidedly condemned.

(Slide) These are diagrammatic sections. Here is a tremendous prostate. This man was some eighty years old, a bad risk. I performed five operations on him, taking only twenty-two sections out altogether. That man has a perfectly normal bladder function today, has no residual, and is perfectly happy after three years, and the prostate is about normal in size.

Here is his prostate at this time, in comparison to what it was then, with only twenty-two pieces removed.

Here is an illustration of a patient's gland which had only six pieces removed at one time. Here is one with—I don't know how many. Here is one which had forty pieces removed, and he is still as well as this man with twenty-two, and his prostate is not so large.

Some of the prostates show more tendency to recede than others. Let's give them a chance at any rate and not subject them to too extravagant resections with raw surface and poor drainage.

I know that this operation, transurethral surgery, is bound to have a larger place for the relief of prostatic obstruction. Just how large a place it is going to occupy will be wholly determined by patience and persistence. I do believe, however, that we must be guarded and careful in protecting this type of surgery from the hazard that some incompetent cystoscopist is going to give it and thus set the pendulum back, because he expects to go in and find it easy and will do all sorts of things because he is not acquainted with all the delicate attendant procedures. We must be very guarded in the execution of the process.

(Slide) These are tubes full of tissue which were removed at one time.

DR. H. G. HAMER (Indianapolis): In discussion of Dr. Lower's and Dr. Hicken's very excellent paper upon the influence of the hypophyseal-gonadal hormone upon, and causation of, the hypertrophy of the prostate, I will report a case of atrophy of the prostate following the removal of a tumor of the pituitary.

This man came to us in 1909 at the age of thirty-two for stricture of the urethra and prostatitis. He was given periodic soundings and prostatic massage over a period of years. In September, 1925, he complained of failing vision and was referred to an oculist. The oculist, after studying his case, referred him to Dr. Frazier of Philadelphia, who diagnosed a tumor of the pituitary and operated for the removal of the tumor.

He was observed by us again in December of 1926, at which time it was found that there was considerable atrophy of the prostate. Again in February, 1929, there was further reduction in the size of the prostate. In February, 1931, there was no prostate palpable, and a total absence of sexual desire and erections.

DR. NATHANIEL P. RATHBUN (Brooklyn): I think the gentlemen who have worked out these methods of transurethral resection of the prostate have made a remarkable contribution. I can't help feeling, however, that many of them are stressing the operation a little too much. I have a feeling that in the long run this operation will, as all operations do, gravitate to its proper level and will be used on a properly selected case and not be quite so generally used as it is by some men at the present time.

The second point, which I think is even more important, is the thing that Dr. Caulk emphasized, and that is the danger and the risk in the operation itself. I don't know of any operation in urology that has received as much publicity as this particular operation has. Everybody seems to know about it. Even the laity know all about it and sometimes come to us and demand that this operation be done. I think, as a result of that, a lot of men who have the price of buying an outfit—that is pretty good in these days, too —are going to undertake to do this operation, and I think there are going to be a lot of casualties that will never appear in the literature.

Along that line, I want to report a casualty which occurred in my own clinic only last week. This was a man we concluded was adapted for this operation, a poor risk with rather a large prostate. The operation was turned over to one of my associates whom I considered and still consider a capable man. He removed a lot of tissue. It was a rather long operation under spinal anesthesia. He left the operating room and left the house man to watch the bladder. The house man noted he was not getting all the fluid back. In the meantime, the spinal anesthesia wore off and the patient complained of severe pain and collapsed. He rallied a little under appropriate measures.

I saw him an hour later. He obviously had rupture of the bladder. We drained his peritoneum. It was filled with bloody fluid. We found a rent in the bladder just above the trigon, through which the fluid had been seeping. I don't know exactly how that occurred.

The important thing is, we are dealing with a powerful factor in the bladder, and even in the hands of a fairly expert man this accident may happen. It certainly is going to happen rather frequently in incapable hands. I think these things should be stressed and emphasized.

DR. F. R. HAGNER (Washington, D. C.): I feel very much about this operation as Dr. Rathbun does. Men are going to do it who are not capable of doing it. As he said, everybody is buying these instruments now, and there are going to be a lot of bad results. Time will show the type of obstruction best applicable to this operation.

I want to say just a word about our guest, Dr. Davis. I have had the pleasure of seeing Dr. Davis work. The personal element is going to enter largely into the success or failure of these operations. Dr. Davis is certainly an expert. I know that Dr. Davis is an honest gentleman, and I believe that the reports that he makes to us are absolutely accurate. But he is very expert, and many of us are not going to be as expert as Dr. Davis is, and we are going to get very much poorer results than he gets.

I have had only a small experience in these cases, but the cases that appeal to me for intravesical operations are the bars and the small intravesical growths. I rather feel at this time that the larger

intravesical growths are better removed by other operative procedure.

Dr. George R. Livermore (Memphis): I went to New York last fall to see Dr. McCarthy do some of this work. I was very much impressed with it. I was especially impressed with the dangers attendant upon the use of such a powerful current. He stated at that time that great care should be exercised in absolutely knowing what you are doing, and the fact that no one should attempt to do this operation unless he was a competent cystoscopist and urologic surgeon, and knew the anatomy of the neck of the bladder and the posterior urethra thoroughly.

That the moderate prostatic obstructions can be removed by his instruments, there is no doubt. That it is attendant with certain risks and certain dangers, there is also no doubt. Therefore, like Dr. Rathbun, I want to sound a note of warning that it should not be done by anyone unless he is an accomplished and thorough cystoscopist and a urologic surgeon, capable of caring for any emergency that may arise.

In regard to the dangers, I have had thirty-six cases. I have had one death. This was in a man eighty-one years of age, who stood the operation beautifully, so beautifully in fact that I invited a patient, who was to have the operation the next day and was worried about it, to come in and see the old gentleman and note how he had reacted following the operation. He got along splendidly until after the catheter was removed. On removal of the catheter he did not void satisfactorily and the catheter was replaced. That afternoon he had a chill and his temperature rose to 104. He did not react readily from this and got some suppression of urine. His blood chemistry mounted and he died in about fifty-six hours with uremia. Death may result in these cases just as it does in prostatectomy.

Hemorrhage should be very carefully controlled before the patients leave the operating room. It cannot be controlled completely in many cases, and although some moving pictures of this operation are shown with the urine coming out perfectly clear, when they leave the operating room, that is true in some cases but not in all.

The secret of it is what John Caulk brought out many years ago in his punch operation, a large indwelling catheter, supervised

by a nurse who keeps it drained and does not let it become plugged by blood clots.

DR. HENRY G. BUGBEE (New York City): The question of the treatment of prostatic obstruction is of such vital importance that one cannot consider it without reviewing some of the history of prostatic surgery.

If we go back to the first attempts that were made to remove the prostate by McGill in 1887 and Belfield in 1888, we find that while the mortalities even at that time were not as high as one might expect, in view of the fact that they knew very little about the true pathology of the prostate, preparation of the patients for operation, and functional kidney tests, statistics published in 1890 showed McGill's mortality to be 16.6 per cent, and that of Belfield 13.6 per cent. In 20 per cent of the operated cases, however, there was a return of the symptoms; that is, the relief of the obstruction was not permanent. This was found to be due to the fact that the entire prostate was not removed. At that time they recognized an intravesical portion of the prostate and a rectal portion, and removed only the intravesical portion.

Fuller, in 1895, advocated the suprapubic removal of the entire prostate, the rectal portion of the gland being elevated by means of fingers introduced into the rectum. At the same time, Nicoll of Glascow recommended the removal of the entire prostate by the perineal route, opening the bladder suprapubically and pushing down the prostate, so that the entire gland could be reached and removed through a perineal incision.

During the early part of this century, Hugh Young showed what could be accomplished by the removal of the entire gland when the patients were prepared for the operation and the operation properly carried out. His report in 1908 of 128 cases, with no deaths, was a record that could not be approached at that time—and he subsequently reported another series of 198 consecutive cases, with no deaths.

From that time on, prostatic surgery in this country has progressed rapidly, and suprapubic operation, through modifications of technic, has been rendered safer. The results of suprapubic and perineal prostatectomy, when properly carried out, are little short

of remarkable. They compare favorably with any major surgical procedure upon any similar class of surgical risks.

We all know that by draining the bladder the prostate reduces very much in size. We have seen this occur over and over again in doing two-stage suprapubic prostatectomies. Yet, when, at the second stage, we remove the prostate, we find, although it has shrunken considerably in size, there are real lobes left. These lobes have the appearance, grossly and miscroscopically, of a growth. While inflammation undoubtedly plays an important part, I do not believe we can lose sight of the true pathology that is present. There is, in such cases, a definite hyperplasia, which is really an adenoma. If, in such cases, only small portions of the prostates are removed, we will have recurrences.

Young introduced his punch in 1910. That was adopted widely throughout the country, and, by many, indiscriminately. It was found that this was not a simple procedure—that there were complications and even mortalities following its use.

Caulk added a cautery attachment to the punch, and with his persistence in its use has kept alive the intra-urethral approach in prostatic surgery. His work deserves much credit. As Caulk has said, there is a big personal element in this work. Not everyone can expect to obtain the same results, certainly not without employing judgment and skill.

Furthermore, he re-operates in a great many cases. The question comes up as to whether multiple operation of a minor nature should supplant a more serious operation which gives a permanent result.

These later developments in intra-urethral resection of the prostate are most interesting. I am using this method in selected cases. There is a very definite field for this operation. We should not, however, change the well-grounded ideas we have of prostatic surgery, which are founded upon pathology, upon work that has been done for the last fifty years, the result of slow evolution and has reached a height where we have a mortality of which everyone who has done the work conscientiously and well should be proud.

DR. ALEXANDER RANDALL (Philadelphia): I think there are two things that are of importance.

One is, honor should be given where honor is due. The second is, that a great deal of our misjudgment and misunderstanding of

one another is due to a faulty understanding of the fundamental pathologic variation of the diseased prostate and a faulty method in our presentation of material, both in meetings and in publications.

Dr. Bugbee went into history. I am going to take you back to what I believe is the actual original description of the middle lobe of the prostate.

In 1811, under the title, "Practical Observations on the Treatment of the Diseases of the Prostate," Sir Everad Homes said before the Royal Society—to quote his words, "It is now six years since I laid before the Royal Society an account of the middle lobe of the prostate gland in the human body, which I have recently discovered."

Homes' name has been lost, or where used has been applied to an insignificant little aberrant growth that occasionally occurs in the mid-trigonal region. Of his twenty-two plates, which are remarkable wood cuts for over one hundred years ago, I have brought copies of four or five to show you his description of the lobe lying in the midline which he calls the middle lobe of the prostate. (Showing the five slides.)

He shows in varying degrees of size what we today recognize as typical commissural hypertrophy.

To go back to Albarran, who also described the actual origin of this tissue. As you know, Albarran described two types. One he calls subcervical, and that one we today attribute and speak of as Albarran's lobe. The second he described under the term prespermatic, which today I think we are more accustomed to call the commissure lobe.

I think, as long as we are on British soil, it is nice at this date to give this honor where honor is due, and in place of such clumsy nomenclature as Albarran's, "prespermatic gland," or, as I myself have used, "commissure gland," it would be nice today, from now on, to recognize Homes' original work and, where we speak of Albarran's glands, as the superficial pedunculated one which is extracapsular, so the true commissure enlargement, I think from now on we ought to speak of as Homes' gland.

Homes' work is lost, because of the criticism that Jesse Foote wrote, in regard to his presentation and publication. Jesse Foote seems to have been a neurotic sort of individual, probably suffer-

ing from intestinal toxemia, but I have never read such a caustic criticism as he delivered against the presentation of Sir Everad Homes. He also did not hesitate to speak in an equally virulent way of John Hunter's work. As John Hunter survived and Jesse Foote is gone, I think also Sir Everad Homes' work ought to survive.

It is of interest that following the above we hear nothing at all of Homes until Sir Henry Thompson's publication, when he apparently accepted Jesse Foote's criticism about Homes' work. And then we seem to pass over until Freyer comes along, and he accepts Sir Henry Thompson. So I feel, in that way, Homes' work has been actually lost.

DR. HUGH H. YOUNG (Baltimore): Allow me to congratulate Dr. Lower and Dr. Hicken on their splendid research work which has furnished the Association with one of the best papers for many years. I would like to ask of them one question. Is the enlargement of the prostate, which they have produced experimentally, confined to the periurethral glands, as in benign prostatic hypertrophy in the human, or is the enlargement general, involving all the prostatic glandular tissue? I would also like to know whether the posterior lamella or lobe, which is so rarely involved in hypertrophy, participates in the enlargement of the prostate which they have described? Also is it an adenoma? Is the condition not a hyperplasia of the entire prostate, rather than a intraprostatic development of adenomatous spheroids, lobules and lobes, as seen in the human with enlarged prostate?

The symposium upon intra-urethral operations for the relief of prostatic obstruction interests me very greatly, as it seems to have followed my punch operation, which I first carried out in 1908. Just previous to this I had attempted to remove suprapubically a median bar in the case of small, fibrous prostate, but had been unable to get a satisfactory result. It then occurred to me that if I cut a fenestra in the tube of my posterior endoscope, and blocked up the terminal opening, it would be possible with an inner cutting tube to remove bars and lobules that were entrapped in the fenestra. And this simple instrument, which I called a prostate excisor, gave excellent results. Three years later, having found that postoperative bleeding was troublesome (although we had not lost a patient from it), I devised a cautery instrument, which was

made for me by Loewenstein in Berlin, and which I have since used in many cases. In all of the early operations I used an external endoscopic light, so that the cuts could be made under visual control. Later I found that this was generally unnecessary. Eventually we came to depend almost entirely upon fulguration of the bleeding points in the cut area to arrest hemorrhage, and I still believe this one of the most radical and effective operative technics yet presented.

In my first paper I called the instrument a prostatic incisor, but the operation was soon dubbed "the punch" by members of the staff. Most of the instruments which have subsequently been put on the market employ a fenestra to entrap the lobe or bar, but the method of carrying out the excision has been obtained by various methods, many of which have been described here today. In my early papers I insisted that the operation should be reserved for contractures of the vesical orifice, posterior or anterior bars or valves and small hypertrophied lobules, principally of the median type. Of 3,300 cases we have employed perineal prostatectomy in 2,203; suprapubic prostatectomy in 168; the punch operation in 501; punch operation for carcinoma, 36; radical perineal prostatectomy for carcinoma, 39; sub-total radical perineal prostatectomy for carcinoma, 17; conservative perineal prostatectomy for carcinoma, 320. Our mortality in the 2,203 cases of benign prostatic hypertrophy treated by perineal prostatectomy is 4.5 per cent. This includes cases in which operation was performed by internes and occasional operators, some of whom have left a mortality of over 10 per cent. It happens that my mortality to date is about 2.8 per cent, but I have had several periods in which there have been between one and two hundred patients operated upon consecutively without a single death. Cecil, of Los Angeles, had nearly 400 cases with only 0.7 per cent mortality. Davis, of Omaha, has a mortality of 2.7 per cent in nearly 500 cases. Colston has recently had nearly 100 cases without a death, and Frontz, Goldstein, Lowsley, Wesson, Hinman and others have had similarly low mortalities with perineal prostatectomy. If, therefore, it is possible by means of the perineal route to enucleate the entire adenomatous enlargement with an extremely low mortality, why should we adopt for such cases an operation which is manifestly incomplete and partial, and which in the hands of many has already shown a

much higher mortality than perineal prostatectomy. Dr. Alcock's frank and detailed description of his results with the so-called resectoscope, has given us all something of a shock, has shown conclusively that one must proceed carefully with this new electrical procedure, and that it is not to be adopted universally by occasional operators and in all types of prostatic obstruction without occasional fearful results. Could we have at hand the true mortality statistics from all over the country we would find many worse than those so frankly reported by Dr. Alcock, whose splendid paper should be studied most carefully by all.

I hope that I am not misunderstood. Far be it from me to suggest that the punch operation, or its various modifications, carried out by the many ingenious and beautiful instruments which we have had here presented, has no place in prostatic surgery. As a matter of fact, it has a very large place, probably larger than we have granted it in our clinic, but it is very evident to me that there still remain a large number of cases of prostatic hypertrophy, especially those of medium and large size, in which prostatectomy, especially by the perineal route, is the better, safer, more thorough and permanently curative procedure. As to the name of the operation perhaps there will still continue many varieties of nomenclature. I first called it excision. Then McCarthy called it revision (perhaps because there has been a revision of the instrument and method so frequently). Then there are the resectionists, and I suppose those who use Dr. Kirwin's beautiful instrument will be called rotarians.

Dr. A. J. Crowell (Charlotte, N. C.): I just want to emphasize what Dr. Caulk had to say in his paper about it being unnecessary to remove the entire prostate gland. Draining the bladder is all that we want, and this operation does not interfere with the physiologic function of the gland. We simply remove the obstructing portion.

This is a dangerous operation in the hands of one not skilled in operative cystoscopy. I understand many general surgeons are purchasing the equipment and I predict that fatalities are going to run high and the operation will be brought into disrepute.

Dr. John H. Cunningham (Boston): What Dr. Young has suggested about getting a record of the mortality of this procedure

is, I think, very important. By so doing, we may form our own opinion as to whether or not we are going to use it.

The suggestion Dr. Young made of getting this information might very profitably start now in the closing of the discussion of each paper. If we had mortality figures from the most expert, we would have reliable data, to contrast with that referred to, which will undoubtedly be less favorable from the employment of the method by those less expert.

I am very glad to express my appreciation of Dr. Lower's contribution. It seems to me that in all the years I have been a member of this society I have never heard a more fundamental paper presented than this work that Dr. Lower has brought to us. It seems to me that these subjects that belong in the field of biophysics and biochemistry usually come from scientists and not from those of us whom I choose to term, in clinical medicine, as "repairitists." Such a contribution, coming from clinical men actively interested in clinical medicine, and also a member of this society, I think is one of the most pleasing things I have heard since I have been connected with this Association. I wish to congratulate Dr. Lower and Dr. Hicken.

DR. FRANCIS S. WATSON (South Dartmouth, Mass.): Belonging to another age and looking in perspective at the present developments, I am considerably disturbed at finding that I do not understand most of the language you younger gentlemen use today. However, I wish to take this opportunity to add my word of admiration to that just spoken by Dr. Cunningham, with regard to the work of Dr. Lower and his associate, which is, or promises to be, of very unusual value, and which is an extraordinary contribution. I am greatly impressed. I know enough to know that it is a very important contribution, and I congratulate them.

DR. H. L. KRETSCHMER (Chicago): I would like to compliment Dr. Lower and his associates on their presentation of this very extremely interesting and fascinating subject.

It is a well recognized fact that patients who have lost their testes, due to infection, may subsequently, when they reach the prostatic age, develop benign hypertrophy of the prostate. I wonder if Dr. Lower could clear up this point for me.

In regard to the paper of Dr. Davis, I also wish to stress the

point that has been stressed by several of the other speakers regarding the simplicity of this procedure. I think it has been extremely unfortunate that so much publicity has been given to this subject from the standpoint of its simplicity. As a result of this, a good many practitioners and surgeons have obtained the idea that all that is necessary for them to do is to purchase an outfit and then start in doing resections. I believe the technic is something that should be developed by men who are accustomed to this type of manipulation. I think, when mastered, it is relatively simple, but I don't believe the idea should be current that anybody can do it, and that it is simple.

I wish to refer to one patient who died of an acute pyelonephritis following the resection. This patient was one of the very early cases upon whom I operated and used the resectoscope. And, because of failure to relieve his symptoms completely, a second resection was done. I now believe this was done much too early after the first operation. In other words, I believe that if enough tissue has not been removed at the time of the first resection, it is not advisable to carry out the second resection for some time, say in three weeks or thereabouts.

DR. HERMON C. BUMPUS (Rochester, Minn.): In closing, I want to give the figures Dr. Young requested.

Up to January of this year I had operated in 250 of these cases with six deaths. No deaths have occurred in the last 107 cases in which operation was performed by my associate, Dr. Thompson, and me.

Several of the essayists have left the impression that following prostatectomy functional results are invariably good. In the 250 cases just referred to, sixteen patients had undergone previous prostatectomy and resection was required to give a satisfactory functional result.

(Slide) I have some slides which show the final results of these 250 cases. Before operation the residual urine varied from 150 c.c. to complete retention in over 100 cases. Following resection we tried to have the residual checked on all the patients before they went home; 120 had none and twenty-nine had less than 30 c.c. In seventy-nine of the earlier cases, where the results were satisfactory, the residual was not checked, so many of these were also probably free of retention.

(Slide) This is a series of ninety-six patients operated on over a seven-year period from each of which adenofibromatous tissue was removed; eighty-six of these patients are living at the present time, and sixty-eight of them wrote the results were perfectly satisfactory; eighteen were disappointed. Of these eighteen, four later had to have prostatectomy.

The instrument which we use is Dr. Braasch's cystoscope in the barrel of which is a fenestra. Instead of controlling the bleeding by resecting with a cautery knife or wire loop, excision is made with a tubular knife and the bleeding is controlled by electrocoagulation. Before the knife is passed, its course through the tissue is rendered ischemic by a multiple needle electrode, the needles of which are so placed as to coagulate the exact spot the knife will cut. If there is any bleeding after excision, it is controlled by a single flexible electrode.

DR. T. M. DAVIS (Charlotte, N. C.): I certainly want to congratulate Dr. Lower and Dr. Hicken on the work they have done. It is an inherent property of medicine that when we progress and get to about the time of the millennium for this condition of prostatic hypertrophy, someone comes along and develops a method by which we won't have any hypertrophy of the prostate. It looks as if we are resecting the wrong gland. I am going to have to build up a method of resecting the anterior lobe of the pituitary.

I do think there is a "coagulaphobia" among a number of the men. It may be they have a misconception as to the amount of coagulation that is proper. I think the amount of coagulation should be adequate for the control of hemorrhage and the control of hemorrhage only. I think probably I have been unusually fortunate in not having many complications, but I believe they are probably due to vessels which have not been properly coagulated. When you have a column of blood coagulated in the vessel it gives an avenue of infection in the vessel itself. I think if you coagulate that vessel, you do not have this tendency to extension.

I have seen very little trouble following proper coagulation, although in several cases I know I have used excessive coagulation without any detrimental results as far as the patient's reaction is concerned.

I have enjoyed very much hearing these papers.

DR. EDWARD L. KEYES (New York City): My compliments to Dr. Lower and his associate, of course.

May I report one death after the McCarthy operation? This was carcinoma of the prostate, extending to the trigon and elevating it. I burned it so deeply that this sloughed through it and the patient died eight weeks later as a result of pelvic abscess with direct communication to the cavity of the bladder.

My great difficulty with the newer operation has been the inconvenience that some of my patients have suffered (quite a number of them) from prolonged discomfort following the operation. I have had two patients who have been just as uncomfortable following the operation, for all three months, as they had been before.

DR. WILLIAM E. LOWER (Cleveland): I want to assure you of our appreciation for the very gracious acceptance given our efforts.

As to the eunuchs with enlarged prostates, I must admit I have never seen any. We have examined very carefully ten eunuchs and all of them had small prostates. I recall one case in particular, that of an elderly man who had an epithelioma of the penis and an enlarged prostate. I did an excision of the penis, the inguinal glands, and also castrated him and placed the urethra in the perineum. Three years later the prostate gland was reduced to about the size of a horse chestnut, and it was very fibrotic.

In all our experimental work, we endeavor to find some clinical application. We are interested particularly in knowing whether or not we may develop something which might possibly prevent prostatic hypertrophy.

Although our series is not large, we believe, from our examinations, that excessive hormone is present in those men suffering from large prostates. We know that if an animal is castrated, the first thing that develops is an increase of the anterior lobe of the hypophysis. Maybe this additional increase produces more of the hormone, which in turn produces hyperplasia of the prostate.

It has been noticed, but not definitely proven, that after castration if an aqueous solution of a testicular extract is injected, the increase in size of the anterior lobe of the hypophysis is prevented, so it is just possible that there are two hormones in the testicle, one an "inhibiting hormone." If that can be proven—and we are working on it now—we may have a remedy which might prevent pros-

tatic hypertrophy. Of course, much work yet remains to be done before this contention can be proved, but we are getting some very interesting results.

In relation to the intra-ureteral resection of prostatic obstruction: a short time ago, Dr. McCarthy wrote a paper giving it a rather catchy title, "The Prostate at the Cross Roads." If this be true, I believe that it is very important that there be the right kind of traffic "cops" at those cross roads. I should like to see those men who are more experienced in this line of work take the cross roads and direct the inexperienced as to the direction they should take. Unless they do, many would-be operators are going to wander off to nowhere and have a great deal of trouble.

We have had some experience with the resection by the various methods. My associate, Dr. Engel, did most of this work. We have had 108 cases of resection with one death, in a case of malignancy with generalized metastasis in which the patient died from pneumonia five days after the resection. In 80 per cent of the cases relief was obtained; a small number of these patients still are carrying some residual urine. Dr. Engel has not hesitated to resect a second time, believing it a better procedure than to resect too much at one time.

It is not a simple procedure and requires great technical skill to obtain the best results and to prevent a high mortality.

DR. JOSEPH F. MCCARTHY (New York City): My compliments are especially directed to Dr. Lower's young associate, not only for the enthusiasm he manifested but also for the constructiveness of his thought and the charm of his presentation.

Dr. Caulk stressed the importance of caution. I, too, have emphasized that in every communication spoken or written, because I anticipated some such eventuality as has occurred. The thing carries tremendous appeal, and it is perfectly logical that men who feel they can handle a cystoscope, undertake this work without having sufficiently familiarized themselves with the exacting technical requirements of the method. It is to be expected they will experience accidents.

Dr. Young, in his gracious manner, has reported a series of fatalities. This, of course, is very regrettable, but I am quite sure that the degree of shock experienced would be much more pro-

found, were the mortalities tabulated, as promiscuously performed in the much more major operation of prostatectomy.

Dr. Rathbun called attention to a rent in the bladder. Of course, a rent in the bladder can occur in two ways: First, with indiscriminate manipulation of the loop while charged with the current. There is no method sufficiently prescient to replace the elements of technical skill and surgical judgment.

A rupture of the bladder may also result from forced irrigation, especially when the patient is under spinal anesthesia. This should be most carefully guarded against. It is one of the reasons we do not recommend spinal anesthesia. Routinely, we employ sacral and paravertebral novocaine, and deep urethral instillations of diothane.

Case selections were mentioned. I think this is the crux of the whole question—proper case selection. I believe the large lateral lobe, the type that bleeds easily when an instrument is introduced, is a pretty good case in which to avoid performing endoscopic revision. We all have had cases where the simple passage of the endoscope has caused bleeding or pronounced temperature excursions that last for hours or days. Such cases should be sedulously avoided.

Dr. Livermore stated that one should not perform this operation unless he be an accomplished cystoscopist. That is not enough. An accomplished cystoscopist may be at sea when he meets postoperative complications, such as hemorrhage. He must not only be an accomplished cystoscopist but a qualified urologist, capable of arriving at prompt decisions, and the ability to carry out any necessary form of intervention.

Dr. Bugbee discussed the time element. The time element must be considered in comparison with prostatectomy, the anxiety of the patient and the family as well as the economic aspects of the prolonged hospitalization of prostatectomy.

Such factors must be reckoned with. Mind you, I am not over enthusiastic; I have had ample clinical experience, and am making an earnest attempt at accurate evaluation of the method, rather than an exploitation of it. I am convinced the method will merit and maintain a very large field of application, in the surgery of the prostate. Dr. Alcock's mortality should not be given without emphasizing the fact that his patients are of extreme age, that many of them are institutionalized. However skilled an individual

is instrumentally or clinically, he is likely to have trouble in his first attempts. In other words, each of us must serve an apprenticeship. As yet I haven't quite finished mine.

Dr. Caulk's seven-year case, presented by Dr. Bumpus, proves conclusively, to me at least, one of the points made in my paper, which is that the lateral lobes play a very minor rôle in the mechanism of urinary retention. Because in this case as shown by him, you will find well developed lateral lobes after seven years, with the ability completely to empty the bladder.

Dr. Keyes commented on prolonged discomfort following operation. Such discomfort depends on the degree of coagulation. If there is extensive deep seated coagulation, the postoperative discomfort may very well last a considerable time. We should dissociate urethral from hospital convalescence. Urethral convalescence in the best conducted cases, in my opinion, will last four to six weeks. By that I mean, endoscopically speaking, before one sees a perfectly normal urethra. Symptomatically, my patients have some increased frequency, some pyuria, but these, in the majority of instances, soon disappear. In any event, generally speaking, the clinical end-results have been most satisfactory to date.

Dr. Lower brought up the very important question of secondary infection. I believe some of the infections that have taken place have come from secondary revisions, carried out before urethral convalescence has been completed, something to be avoided.

As to the deaths in my series, I thought I had more cases, until we tabulated them. My associates and I had 120 odd cases to date. In those 120 odd cases we had two deaths. In but one was it necessary to open the bladder for late postoperative hemorrhage. The death I had was in an outside clinic, as was also the death experienced by one of my associates. I have not had a single death at the Post Graduate Hospital in all the cases, ward or private, I have done by any method, during the past year and a half. This statement should be qualifled by the reservation that one death from late pyelonephritis with associated bilateral renal calculi is recorded in our records. This case, though highly debatable, is, for reasons of accuracy, included. We have had to intervene for postoperative hemorrhage in probably three or four cases, which inter-

vention consisted of the introduction of a pan endoscope, visualizing the bleeding point and coagulating.

I believe organization is one of the most essential elements in the care of these patients. Anyone who treats this aspect casually is bound to experience mortality. Special nursing is the rule with private patients, and even charity patients should be provided with special night nurses. I fully agree with the gentlemen who have spoken on this subject, that caution should be emphasized by all of us, that apprenticeship should be stressed, that it should be restricted only to men who are fully qualified, and that time alone will prove the precise limitations of the method.

MANAGEMENT OF UNDESCENDED TESTICLE

CHARLES M. McKENNA, M.D., and EARL EWERT, M.D. (by invitation)
Chicago, Illinois

When the final treatise is written on the subject of undescended testicle, in the opinion of the authors, it will be divided into two distinct chapters, one the embryology, histology and physiology of undescended testicle, and the second, the anatomy, technic of operation, and end-results. In the former the name of Dr. Carl Moore of the University of Chicago will stand out prominently, while in the latter the names of Bevan, Torek, Meyer, Cabot, Cunningham, Keyes, Wangensteen, Eccles and others will be noted. Bevan was a pioneer in this work and deserves particular attention because he has continued to perfect his original operation, so that at the present time his technic is more generally accepted than any other method. To date there have been more than forty different operations described in the literature. That is the best evidence that no one technic has been accepted as a standard. This paper will deal chiefly with the anatomy, technic of operation, and end-results. In passing we cannot refrain from mentioning the splendid research work done by Dr. Carl Moore, which was presented in a paper before this society two years ago. He was the first one to point out the thermostatic value of the scrotum. He proved beyond doubt histologically that the germinal cells took on an irregular appearance when the testicle was allowed to remain in the peritoneal cavity or the inguinal canal. His work proves that the best time to operate on patients with undescended testicle is before the age of puberty. Every urologist should be familiar with Dr. Moore's writings.

We believe the proper time for this operation is between five and nine years. At this period the tissues of the cord are sufficiently developed so that one can operate with better results than at an earlier age. There is some difference of opinion as to whether or not in cases of bilateral cryptorchidism the patient will be fertile if the testicles are placed in the scrotum after the age of puberty.

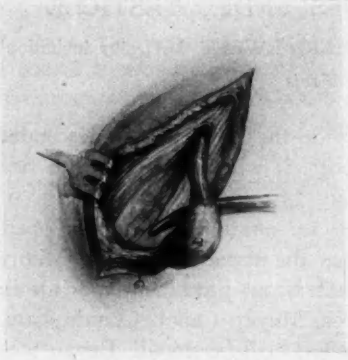

Fig. 1. The gubernaculum attached to the superficial fascia.

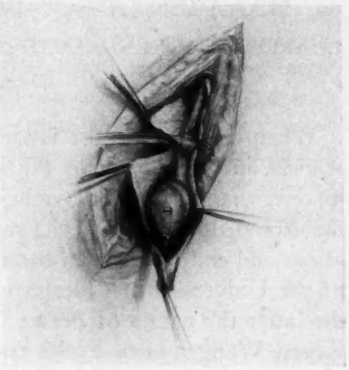

Fig. 2. The peritoneum lifted from the spermatic vessels with a groove director.

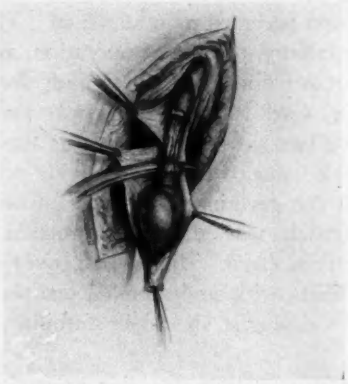

Fig. 3. The small artery forceps are peeling off the peritoneum from the spermatic vessels. The same method may be applied to the proximal portion of the cord.

Dr. Moore is unable to say whether or not fertility will be present in such a case, as his work has been exclusively on animals. At the present time we have under our observation a patient, twenty-nine years of age, with bilateral cryptorchidism, who was operated on by another surgeon for bilateral inguinal hernia. As this operation the surgeon pushed the testicles back into the peritoneal cavity, and closed the rings. The best evidence of this man's sterility is that he has been married for several years without progeny. It is our thought to operate on this man and at a later date report negative or positive findings.

Classification.—We have classified this entity into four groups: First, the testicles that are in the peritoneal cavity; second, those that are in the inguinal canal; third, those just below the inguinal canal, and fourth, the migrating type, in the scrotum and in the canal.

Etiology.—The etiologic factors described by Eccles are: "First conditions associated with the mesorchium; second, those associated with the testis and its component parts; third, conditions associated with the gubernaculum; fourth, conditions associated with the cremasteric; fifth, those associated with the route along which the testicle must pass" (Wangensteen).

John Hunter and Bland Sutton were of the opinion that the testicle failed to descend because of imperfect development. Uffruduzzi was inclined to think that heredity played an important rôle.

In most of the patients we have seen we believe the failure of the testicle to descend is due more to the peritonum covering the spermatic vessels and vas deferens than any other one factor. We have seen three cases of anomaly in which the epididymis was not in proximity with the testicle. We have seen two cases where the patient did not present an external inguinal ring. In one of these, an adult of thirty-four years, no difficulty was experienced at operation in bringing the testicle down to its normal bed.

It is generally agreed that if the testicle does not descend within the first twelve solar months after birth, it will not descend of its own accord. One of our patients, however, a dentist of forty years, gives a history of having been born a unilateral cryptorchid, but the testicle did descend of its own accord at the age of fourteen

years. I might add that this patient was operated on for an inguinal hernia just before entering the Army during the World War.

Frequency of Occurrence.—An observer in the Austrian Army showed that out of every 1,000 men drafted an average of 2.2 had undescended testicle. Marshall found eleven in 10,800 cases; Rennie found six in 10,800 cases; while in the late War the

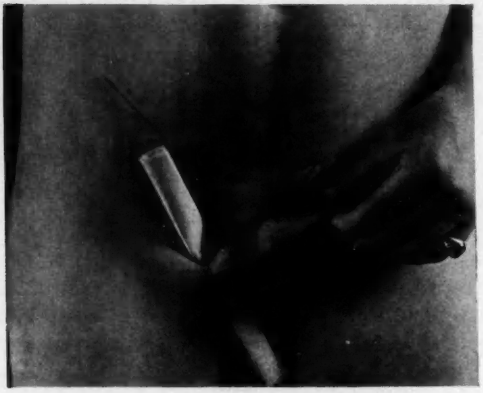

Fig. 4. The result in a patient thirty-four years of age.

records of U. S. Army Medical Department showed that 3.1 per 1,000 cases showed failure of the testicle to descend.

Indications for Operation.—The indications for the operation are summed up in the following way: First, we believe that all cryptorchids should be operated on before the age of puberty, provided the general condition permits; second, because of the possibility of the undescended testicle undergoing malignant change in later life; third, because of the association with inguinal hernia; fourth, because of the possibility of traumatism; fifth, because of pain due to the position of the testicle; sixth, for cosmetic purposes. It has already been pointed out that if the testicle is not placed in its normal bed the patient has a good chance of being sterile on that side. While statistics differ, authors do not agree on malignancy. Many surgeons point out that it is sufficiently important that when this condition does arise an operation is

strongly indicated. Wangensteen in a recent article declares that it is more likely for the undescended testicle to become malignant than for a normally descended one. Bevan, on the other hand, does not recall having operated on a single patient in a case of malignancy in an undescended testicle. Cunningham, in 1921, found that in 462 cases of malignancy of the testes, forty concerned the undescended testis. Kocher observed one case of cancer in 1,000 cases of undescended testicle and Eccles' report of 154 cases showed no malignancy. In our own series of forty-one cases malignancy was not observed in any case, but we saw a case of malignancy of an undescended testicle in an adult operated on by another surgeon. We do not believe that the question of cancer should be the sole indication for operation in the adult.

We believe the question of trauma should be considered in all cases of undescended testicle. This is especially true when the testicle is in the canal or below the canal. It is easy enough to visualize that a testicle in this position is much more easily traumatized than a testicle in the peritoneal cavity or in the scrotum. We have had two patients come to us for cosmetic reasons. One is shown in the picture. He stated that he was always embarrassed when undressing before other men because of the anomaly and felt gratified when the testicle was put into the scrotum by operation. Pain we think is an important factor and is a strong indication for placing the testicle in the scrotum. In the migrating type of testicle, we believe it is necessary to suture the testicle to the scrotum in order to prevent torsion of the cord.

Technic.—All methods of operation are satisfactory in the hands of the inventor of the technic. Bevan's method differs from all others inasmuch as he has presented a technic in which the patient retains a tunica vaginalis after the operation is completed. Torek's method is outstanding because he has devised a means of preventing retraction of the testicle after operation.

There are two things to be accomplished in the operation, one the lengthening of the cord, and the other the retention of the testicle in the scrotum. Bevan believes that he gets sufficient lengthening of the cord to retain the testicle in the scrotum, while Torek and Wangensteen point out that by suturing the tunica albuginea to the fascia in the thigh, the testicle will remain in its normal position. In our work where there is any question of shortening

of the cord after the operation is completed, we follow out somewhat the method described by Wangensteen except that we use a portion of the gubernaculum to attach to the thigh instead of the tunica albuginea.

We make the usual hernia incision parallel with Poupart's ligament, expose the external oblique but do not carry the incision quite as far toward the scrotum as we do in a hernia. This is purposely done to leave as little scar as possible near the spermatic cord. The vacant scrotum is dilated and if a constriction is present, and it usually is, it is incised at two places so that the testicle can remain free without any tension after the operation. We introduce the index finger of each hand for the purpose of dilating and making the scrotum larger. After that, gauze is packed into the scrotum and allowed to remain there until we are ready to place the scrotum in its normal bed.

If the testicle is below the inguinal canal and the gubernaculum is attached to the superficial fascia, this is dissected out and the gubernaculum divided by means of scissors. The external oblique is now divided just as in performing an inguinal herniotomy; the testicle with its accompanying sac is dissected out as far up as possible toward the general peritoneal cavity. The sac is opened, and the cut edges are grasped with artery forceps, as shown in the picture, including the cord, which gives the appearance of a flat surface. The peritoneum is then divided at right angles to the cord and a grooved director inserted between the spermatic vessels and the vas deferens. The distal end of the cut portion of peritoneum is grasped with an artery forceps. By twisting the forceps, as indicated in the picture, the peritoneum is peeled off the spermatic vessels and vas deferens as far down as the testicle. The proximal end of the peritoneum, which is the upper end of the cord, is now grasped by the forceps and the same procedure is followed toward the general peritoneal cavity. When the peritoneal cavity is reached it is easy enough to make an incision parallel with the cord on both sides and this peeling process can be carried as far as may be indicated in the judgment of the surgeon. We emphasize this method particularly because in all of our cases we have had no hemorrhage. When the cord has been stripped of its peritoneum, it is easy enough to free the connective tissue holding the spermatic vessels and vas deferens. These two procedures

we believe are of the greatest help in elongating the cord. At this point one must decide whether he will follow out the general technic of Bevan of allowing the testicle to remain free in the scrotum, or the technic of Torek. In the event that the cord is short and there is a possibility of retraction, it is always advisable to make an anastomosis between the gubernaculum and the fascia of the thigh through a small opening in the scrotum. In our last twelve cases we have used this technic even though the cord seemed sufficiently long. We would like to point out that this procedure makes the second stage of the operation much more simple, inasmuch as there is no danger of trauma to the testicle. The second step of the operation is done anywhere from six weeks to three months after the first operation. It is performed under local anesthesia and the patient does not have to remain in the hospital.

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A STUDY OF MORGAGNI'S CRYPTS

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Since the earlier days of my urologic studies, the lacunæ, or crypts, of the urethra have had a great interest for me, partly on account of their clinical importance in maintaining infection of the urethra and predisposing to peri-urethral abscess, and partly because of the difficulty of finding any adequate description of them in the books on anatomy or histology.

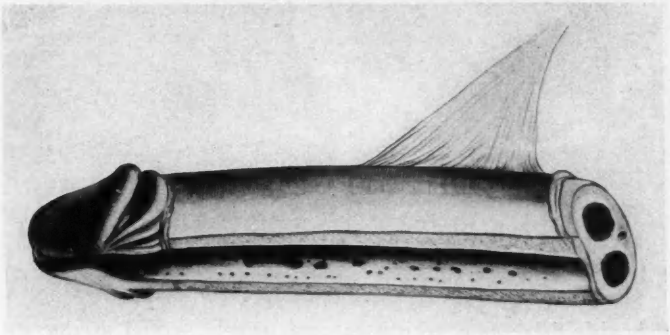

Fig. 1. Urethra laid open showing Morgagni's crypts from Opuscula Miscellanea Pars Tertia. Morgagni, Venice, 1763.

The earliest account of the lacunæ, which open on the surface of the urethral mucous membrane, is by de Graef in 1668, and again in 1706, by Morgagni, who described and showed an engraving of the urethra which was split open, disclosing a number of foramina, or canaliculi, as he named them, on the roof the urethra, the larger, some ten or twelve in number, arranged in a row and lying on the roof, and two ôther series, much smaller and more numerous, placed at the sides of the urethra. With a probe, he found that these canaliculi ran obliquely under the mucous membrane.

Morgagni regarded these crypts as mere blind pockets, without

any communication with the glands of Littré, which were undiscovered at that time, and this view has been generally passed along from one text-book to another.

It always seemed to me that the formation of mere blind pockets in the urethra, without any special function, was unlike all the ordinary processes of nature, and so, with the assistance of Professor Theodore Bauer of Vienna, we prepared a number of urethræ, which were cut and studied. We found, to our great interest, that the supposed blind pockets were in all cases con-

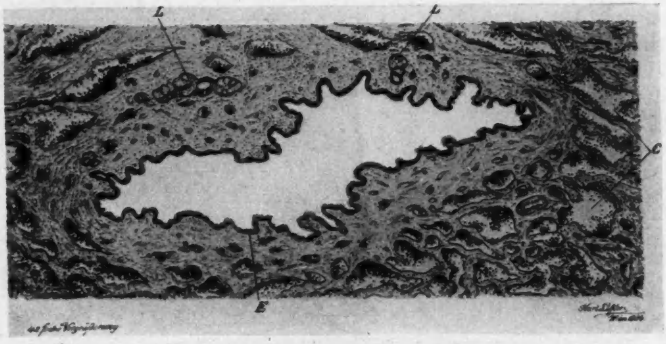

Fig. 2. Cross section of urethra showing Littré's glands.

nected with the glands of Littré, and merely served as ducts for the mucus secreted by them to flow out. This was further confirmed by hundreds of urethroscopic examinations in which could be seen drops of mucus pouring from the open mouths of Morgagni's crypts which evidently, from the quantity noted, must have been secreted by the glands of Littré.

The connection between crypt and gland was not seen in every slide examined because the crypts were cut on a different level from the glands, and, therefore, they did not always appear. When the section was made longitudinally through the urethra, the connection between crypt and gland was more easily seen.

In going over the literature, which is extensive, it is found that some authors deny any connection between Morgagni's crypts and Littré's glands, while others admit that there may be a connection (Pearsall's Anatomy; Szymonowicz and Krause).

The only anatomist who accepts the view that Morgagni's crypts are the secretory ducts for Littré's glands is Sappey (Traite d'Anatomie). After describing Littrès glands as grape glands (racemose) lying chiefly on the roof of the urethra and being located, some within the mucous membrane and others deep in the spongy urethra, he states that they are provided with a large excretory duct which terminates by one or several utricles.

"The orifices of the glands of the spongy portion by which the product of their secretion is discharged, have for a long time been

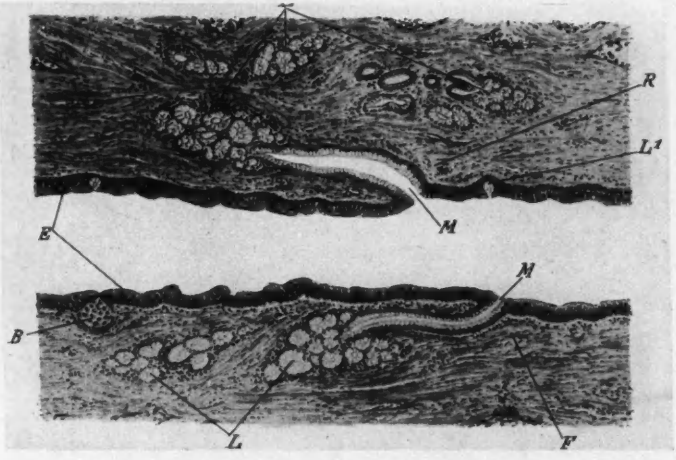

Fig. 3. Longitudinal section of urethra showing Littré's glands and Morgagni's crypts as excretory ducts.

studied. They have been described by de Graef and Morgagni, and are now called lacunæ of Morgagni.

"The glands of Littré are lined throughout the entire extent of the excretory duct (Morgagni's crypt) with cylindrical epithelium."

The view that Morgagni's crypts, or lacunæ, are the ducts provided for the excretion of the mucus formed in Littré's glands, is also held by Szymonowicz and Krause, Cunningham, Pearsall and Koll, but denied by Hirsch and Testut.

It is interesting to note the divergence of opinion in a matter which admits of positive demonstration by microscopic examination of sections of the urethra.

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PRESENTATION OF A CYSTOSCOPIC, IRRIGATING, FULGURATING ATTACHMENT FOR THE CAULK CAUTERY PUNCH

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For twelve years I have used my cautery punch for the removal of an increasing number of prostatic obstructions and have repeatedly reported the results of this operation throughout this

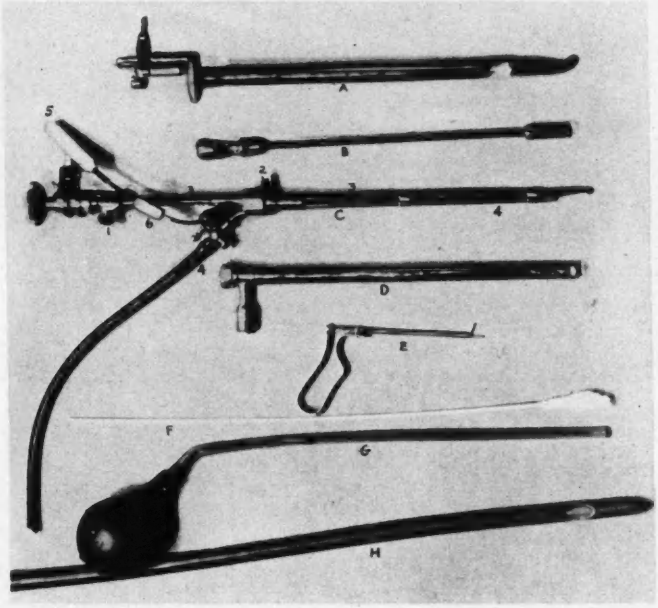

Fig. 1. The cautery punch with its accessories. *A*, punch sheath; *B*, obturator; *C*, irrigating cystoscopic unit—(1) screw for retaining the telescope in an exact position within its sheath, (2) slot for connection with light post on punch sheath, (3) telescopic carrier, (4) irrigating channel, (5) electrode engaged in its channel, (6) bakelite button for manipulating electrode; *D*, cautery punch blade and tube; *E*, forceps for extracting tissue; *F*, cotton pledget; *G*, suction apparatus; *H*, large catheter for drainage.

period of years, showing its gradual application from 20 per cent of all obstructions to almost 100 per cent at the present time with results as entirely satisfactory as by prostatectomy.

I have for years reported the ability to remove innumerable pieces from the internal orifice of the bladder under endoscopic vision with accuracy and safety, free from serious complications and with a very low mortality rate—well under 1 per cent. I observed as far back as 1923 that prostates of considerable size uniformly diminished after sections were removed from their orifices

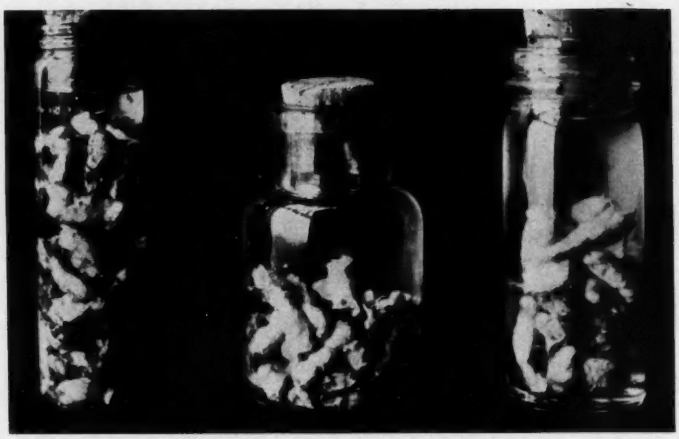

Fig. 2. Specimens removed from three different subjects by single operations.

out of proportion to the amount of tissue excised and through this observation as well as for other definite reasons previously enumerated, I concluded that the majority of the growths were inflammatory in nature and have endeavored to impress the profession with the value of local drainage of the prostate itself.

Within the last two years more and more pieces have been removed at one sitting in order to protect against too many repeat operations. During the last six months with the improved attachment which I am about to present and which has unquestionably added more accuracy to the operation, it has been observed that

any number of sections can be removed from the orifice in a short period of time. I feel that with this instrument more tissue can be removed in less time and with greater ease than by any other method with which I am familiar.

The punch operation has not met with popular professional approval in dealing with large obstructions because of the general belief that visualization was imperfect through the reflected light system. For this reason I have had constructed, by Mr. Phillips, a carrier which is composed of several compartments very much

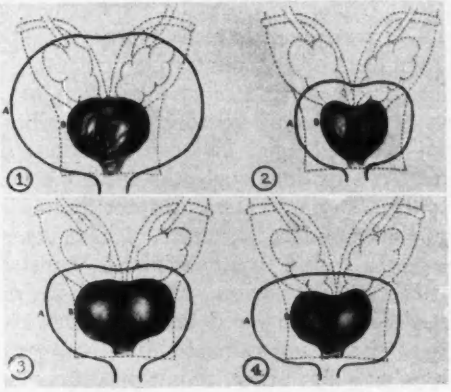

Fig. 3. Comparison in size of prostate before and after operation: *A*, before; *B*, after. Number 1 had a much smaller amount of tissue removed than Number 4. Number 2 had only six bites removed; Number 3, over twenty. This illustrates the effects of absorption through drainage of the prostate.

like a gun, with a sight at the top, without ratchets or screws for the purpose of clamping the light to the carrying post of the punch sheath. The carrier attachment incorporates an irrigating channel, a canal for the introduction of a fulgurating electrode as well as an encasement for a McCarthy foroblique telescope. This attachment moves easily to and fro within the sheath of the instrument, uncomplicated by any attachments, and is very inexpensive. The punch tube is inserted into the bladder, the attachment is passed down the sheath of the instrument, irrigation started, and the orifice is vis-

ualized. The trigone, bladder wall, and urethra can be observed as readily as with any cystoscope, and by manipulating the instrument the obstruction is seen approaching within the slot. As it begins to enter, the attachment is gradually withdrawn and the obstruction is seen to roll within the slot. The usual punch grip is then employed, the field is dried, endoscopic light is reflected as previously done and the orifice re-visualized or double checked. In this way one can be perfectly certain that the prostatic orifice is accurately grasped. The punch blade is inserted as usual and the tissue removed, the cautery blade is extracted, the attachment re-inserted, irrigation started. If there are bleeding points, the fulgurating electrode is carried forward and they are fulgurated. The little bakelite button on the electrode facilitates manipulation.

With this instrument one can remove any amount of tissue from the orifice that is desired under perfect visualization both through cystoscopic and reflected light, and can accurately determine the exact location of obstruction, apply the instrument and after the operation is apparently complete can inspect the orifice thoroughly for remaining lobules or bleeding areas. I have removed as many as twenty-five pieces within twenty minutes. I feel that time is a decided element in the operation. Prolonged instrumentation is to be condemned. I am convinced that the removal of too much tissue at one operation is unjustifiable, that the procedure must be kept as benign as possible; hence, repeat operations are preferable.

I furthermore believe that actual cauterization is superior to any type of high frequency excision. It presents less tendency to be complicated by a hemorrhage, sloughing, secondary necrosis and scar.

This improved instrument embodies certain features lacking in the previous model which will ultimately enable it to attain a higher degree of efficiency in the treatment of prostatic obstruction.

DISCUSSION

Dr. Edward L. Keyes (New York City): I have performed Dr. Cabot's operation, which is a sort of modification of the Torek, in that he inserts an elastic band for elastic traction between the testicle and the thigh. I have performed it in two cases, both bilateral, and therefore four testicles, and have been very pleased with it.

Dr. Cabot has also informed me that he has found that when he could not bring down an intra-abdominal testicle all the way at the first operation, he was quite satisfied to leave it as far down as he could get it and re-operate later. He found there was no difficulty then in getting it to the bottom of the scrotum though he had been unable to do so in the first instance.

THIRD DAY, MAY 28, 1932

FATAL EMBOLISM DUE TO DISTENTION OF BLADDER WITH AIR

HOWARD S. JECK, M.D.

New York City

For the past five or six years it has been our custom on the Bellevue Urological Service to proceed as follows in performing a suprapubic cystotomy. A soft rubber catheter is passed into the patient's bladder, the bladder is emptied and then irrigated with some weak antiseptic solution, usually acriflavine 1/5000. The catheter is then held in place by means of adhesive strips, and an inflation bulb, similar to those used on the ordinary blood pressure apparatus, is attached to the catheter by means of a connecting rubber tube about 3 feet long. The operative field is sterilized and the patient draped for operation. The inflation bulb is then brought outside of the sterile field. Under local anesthesia the usual midline incision is made, and after reaching the fascia transversalis the bladder is ready for distention. While the operator holds one hand over the bladder, a nurse pumps air into the bladder by means of the inflation bulb until the bladder rises sufficiently high to permit of opening it with facility. It usually takes from three to five bulbfuls of air to produce the proper amount of distention. After the bladder is sufficiently distended the fascia transversalis is incised transversely above the pubis and pushed upwards together with the peritoneum. The bladder is then opened in the usual way.

During the latter part of December, 1931, an attempt was made to open the bladder of a male patient, sixty-seven years of age, in the manner just described. He was quite a heavy, stockily built man who had suffered from markedly increased frequency of urination by day and night for two months prior to his operation, from nocturia for ten years prior to his operation and on two occasions hematuria—once four years before and the last time two months preceding the operation.

Rectal digital examination disclosed a smooth, elastic, rather flat prostate in which the median furrow could be readily felt. Two cystoscopic examinations done five days apart were unsatisfactory

because of continuous bleeding during the procedure. However, on the first examination there appeared to be a circumscribed inflammatory area with evidence of necrosis in the vault of the bladder. On the second examination the same region appeared to be covered by a sort of irregular blood clot. There was also evidence of a moderate-sized median prostatic bar.

From the meager information gained by cystoscopy plus the history, a diagnosis of tumor of the bladder, probably malignant, was made and an operation was decided upon. Since the lesion appeared to be in the vault of the bladder it was thought that should a tumor be disclosed by operation it could probably be resected. The bladder neck would then be dealt with at the same time or else operated upon at a later period as the operator should see fit.

The balance of the physical examination was essentially negative. The urine showed a trace of albumin and a few red and white blood cells. The non-protein nitrogen was slightly elevated and several phenolsulphonephthalein tests showed moderately good kidney function. The blood pressure was 116/68 the day prior to operation.

In this case the operation was performed under spinal anesthesia: 120 mgm. of novocain were injected into the spinal canal between the third and fourth lumbar vertebræ according to our usual technic, which consists in dissolving the novocain crystals in about 4 c.c. of spinal fluid and then re-injecting the spinal fluid.

It was agreed that the resident house officer should begin the operation and proceed until the bladder was exposed, at which stage I would take over the operation. After the resident had reached the fascia transversalis and handed his scalpel over to me, we called for dilation of the bladder. The head nurse of the operating room injected about two bulbfuls of air in the usual way, the bladder rose part way from the pelvis, there was a hissing noise as if the air were escaping and then the bladder immediately sank back into the pelvis. Inasmuch as air not infrequently escapes around the catheter we called for more dilation and this time he injected about three bulbfuls of air. Again the bladder rose to some extent from the pelvis, again there was the hissing noise, after which the bladder immediately collapsed. We were about to call for another attempt at dilation when the patient made a sort of convulsive movement which attracted our attention. He was slightly cyanotic and we asked him if he felt all right. He replied, "Yes," but within a very few seconds his pupils became dilated and the cyanosis deepened very perceptibly. We then immediately began to give artificial respiration. The cyanosis rapidly deepened, until he was almost as blue as indigo, his pupils were widely dilated and there were no signs of respiration. Our efforts to revive him by means of artificial respiration and adrenalin injected directly into the heart were without avail. After a half hour's attempt with these futile manipulations, we officially decided that the patient was beyond

aid although I believe all of us felt that he was dead from the moment he stopped breathing. Although this was our first contact with a death of this nature we all felt that the fatal outcome was due to an air embolus. An autopsy was performed and in the following are given the salient points from the autopsy protocol.

Bladder: In the fundus of the bladder on the right side was an irregularly shaped growth measuring about 2 inches in diameter. The bladder wall was thickened in this situation. There was superficial necrosis of the soft tissues in this region and the edge of the growth was nodular. The mucous membrane was injected and showed an area of hemorrhage evidently infected just above the trigone. There was distinct crepitus in the soft tissues about the bladder in the pelvic wall.

The inferior vena cava was opened under water. On cutting the vena cava with scissors underneath the level of the water, bubbles of air and frothy fluid came to the top.

Lungs: The lungs were deeply congested, purplish-red in color and were not lumpy. The apices were somewhat puckered and showed old healed tuberculous scars. The bronchi and vessels were natural.

Heart: On opening the right ventricle *in situ* frothy fluid with numerous air bubbles welled up from the opening. The fossa ovalis was closed.

Death due to the introduction of air into the circulation has been recognized from the time of Morgagni and even earlier investigators.

According to Mathé in his recent comprehensive article published about three years ago, three theories have been advanced as to the cause of death, namely, cerebral, pulmonary and cardiac disturbances. I shall here quote directly from Mathe's article: "Morgagni and Bichat advanced the first theory—embolus formation in the brain itself. Death in such cases was attributed to snycope resulting from anemia of the vital centers of the bulb. Claude Bernard, Vulpian, Quilliot, Wolf, and others favored the second theory. They believed that air in passing from the right heart into the lungs formed veritable emboli which closed the various branches of the pulmonary artery resulting in death by suffocation. Magendie, Amussat, Depage, Goodridge, and others, in supporting the cardiac theory, attributed the grave symptoms arising from the introduction of air into the circulation to the lack of stimulus producing blood in the right heart, or to a direct deleterious reflex action of air in the heart itself. They explained that large amounts of air in the right heart reduced the intracardiac pressure to such an extent that it could not overcome the resistance of the pul-

monary capillaries and that, as the heart beat was of no avail, stagnation of the entire circulation soon resulted, thus causing death by lack of nutrition of the vital centers. Laborde and Frey concluded that death is brought about by a triple mechanism in which all three of the above theories play a rôle.

"All investigators agree that small quantities of air can be introduced into the venous system at intervals, causing slight or only transitory symptoms, due probably to the ability of the blood to absorb air, whereas if the total of these amounts were suddenly introduced under pressure grave symptoms, or death, might ensue."

In his conclusions Mathé states that "death is due to the arrest of pulmonary circulation, to gaseous distention of the right heart, thus preventing function of the tricuspid and pulmonary valves, to too little blood reaching the left ventricle, so that anemia of the vital centers of the brain is produced, and to stasis of the coronary vessels."

121 E. 60TH STREET

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PERICYSTITIS COMPLICATED BY ACUTE INTESTINAL OBSTRUCTION

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The condition known as pericystitis or suppurative pericystitis is of great interest to the urologists in all of its aspects. In this presentation I shall make no attempt to describe the symptoms, diagnosis and treatment of the condition as these have been amply dealt with by others. I wish to put on record three cases which resulted in acute intestinal obstruction. I have found no mention of similar cases as having been encountered in any of the reported series that have come to my attention.

The first case occurred on my Service at the Massachusetts General Hospital in 1931.

Case 1.—An Italian laborer of fifty-eight was admitted to the Urological Service on March 20, 1931. He had a history of four years of urinary symptoms. He was in excellent condition. There was no history of any gastro-intestinal trouble. He had a 9 ounce residual. The urine was uninfected. Rectal examination showed a benign enlargement of the prostate. A preliminary bilateral vasectomy was done and after ten days of catheter drainage a one-stage suprapubic prostatectomy was performed under spinal anesthesia on March 30, 1931. The operation was easy and the gland removed in one piece. A Hagner bag was introduced, a suprapubic tube and a rubber wick to the prevesical space. Postoperatively the patient developed a marked urethritis necessitating the taking out of his urethral catheter. On the seventh day an induration developed high in the right scrotum. This was later incised and 3 or 4 c.c. of thick yellow pus found. On the twelfth day an induration developed high in the left scrotum which was also opened and 3 or 4 ounces of pus evacuated. These scrotal abscesses subsided gradually. The suprapubic wound was slow in closing but was healed at the end of five weeks. Voiding was normal, no residual. As the patient had been running a slight but continuous temperature, never over 100, he was kept under observation although he felt well. In a few days the suprapubic area became indurated, reddened and tender and the sinus re-opened. The wound was then incised. Some pus was found in the prevesical space and a

catheter was re-introduced through the suprapubic sinus. The temperature fell to normal. Three days later the patient began to hiccough and vomit large quantities of sour material. The next day the vomitus was fecal in odor. There was some distention. White count was 11,000. Non-protein nitrogen was 62, previously 44. By rectum there was a bulging mass in the region of the bladder base. A diagnosis of intestinal obstruction was made. This was agreed to by the surgical consultant and an immediate exploratory laparotomy was done by Dr. Reginald Smithwick of the surgical staff, under local anesthesia on May 29. Several loops of distended small intestines were found adherent to the posterior surface of the bladder. An ileostomy was done by the Witzel method, using a No. 16 French catheter. A transfusion of 500 c.c. of whole blood was given. The patient made an uninterrupted recovery and left the hospital on June 30, thirty days after the abdominal operation, in good condition, all wounds healed. He has been heard from recently and is in excellent health.

The result in the other cases was not so happy.

Case 2.—The second case, a man of sixty-one, had a long history of severe bladder infection. Thirteen and a half months before he was first seen in our Out-Patient Department he began to have urinary symptoms which culminated in an acute retention two months later. He was catheterized and a two-stage suprapubic prostatectomy and partial diverticulectomy were done in a neighboring city. Except from retention there was no relief following this operation.

When we first saw him the patient had been passing blood and gritty material for four months. Cystoscopy showed a much inflamed bladder with areas of incrustation on the base. There was no improvement under local treatment so he was referred to the hospital, question of carcinoma of the bladder. When he entered the Urological Service at the end of November, 1930, the urine was foul and bloody. There was dysuria, frequency and suprapubic tenderness. Suprapubic cystotomy was done by Dr. Channing Swan, who found no malignancy as proved by biopsy, but a much thickened and inflamed bladder with fibrin and incrustation and some areas of ulceration which were fulgurated. The suprapubic wound healed slowly because of the marked bladder infection. He returned to the Out-Patient Department for treatment, his symptoms having been relieved by his second operation but the urine still remained very dirty. He was treated with bladder irrigations and instructed in the use of a catheter.

On August 26, 1931, he entered the Emergency Ward complaining of low abdominal pain of three days' duration. Within an hour he began to hiccough and to vomit. The vomitus had a fecal odor. Examination showed a distended, tympanic abdomen, suprapubic tenderness and visible peristalsis in that region; the white count was 16,000. Rectal examination showed the tissues above the prostate

to be indurated. The urine was foul and full of pus. The patient had not been washing out his bladder of late.

A diagnosis of acute intestinal obstruction was made and an immediate exploratory operation was performed by Dr. John Stewart, one of the Surgical Service Residents. Distended loops of small intestines were found adherent deep in the pelvis to the posterior surface of the bladder; one was strangulated. This was freed, the color of the bowel immediately improved and there was free passage of fecal material down through the obstructed loop. In one place the wall of the ileum was necrotic. This area was inverted and the bowel enclosed in omentum. The raw area on the bladder wall was buried by inversion. There was a little dark free fluid in the pelvis. One hundred cubic centimeters of amniotic fluid was used in the peritoneal cavity.

Two days after the operation the patient developed a right bronchopneumonia and died five days after operation. There was no autopsy. In this case owing to the necrosis of the bowel a much more extensive operation had to be done than in the first case. This may have had some bearing on the outcome, although the obstruction was of longer duration.

The third case is a personal communication from my colleague, Dr. Channing Swan.

Case 3.—An elderly man with a badly infected, over-distended bladder, of long duration, was admitted to the Long Island Hospital. He died a few days after decompression of his bladder. Although the patient vomited, the cause was not recognized clinically. It was thought to be due to the digitalis he had been given. At autopsy a loop of bowel was found adherent to the bladder which had become completely obstructed and strangulated by angulation, having been pulled down into the pelvis by the bladder in decompression of that organ.

The etiology of the pericystitis in the first case differs from the other two in that it resulted from extravesical sources, the urethral and scrotal suppurations resulting in an abscess of the prevesical space. The actual suppuration in this case was satisfactorily handled by secondary drainage of the prevesical space and re-establishing suprapubic bladder drainage.

In the other two cases the cause was the long and severe infection of the bladder itself. Of the three cases, although there was no actual suppuration, in two of them there was sufficient infection present to cause an adhesive peritonitis between the peritoneal covering of the bladder and the adjacent coils of intestines.

In a paper read before this society by Dr. Harry Culver in 1927,

reporting seven cases of pericystitis, he says: "Gastro-intestinal symptoms were a marked feature in but one case and this a persistent vomiting." From the case report this was not of peritoneal origin.

Dr. Arthur Chute in a paper read before the American Urological Association in 1922, reporting five cases, mentions one case in which there was hiccough and marked abdominal distention, but, as the urine was scanty and the patient was relieved by administration of fluids, this was evidently due to renal insufficiency.

My object in reporting these cases is to call attention to the fact that grave intra-abdominal conditions may result from pericystitis demanding both prompt recognition and surgical intervention.

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MIGRATORY FOREIGN BODIES IN THE BLADDER

REPORT OF A CASE

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The number of cases of foreign body in the bladder reported in the literature each year is not inconsiderable. The diagnosis and treatment of this condition, therefore, present a distinct and not unimportant problem in genito-urinary surgeery. A review of our private records revealed eight cases of foreign body in the bladder. These were analyzed and reported by H. N. Dorman last year. As might be expected in all of these cases the foreign body reached the bladder by way of the urethra and consisted of objects introduced either by the patients themselves for abnormal sexual gratification or by a physician for purposes of diagnosis and treatment. The great majority of cases reported in the literature belong to this group. An amazing variety of objects has been removed from the bladder, having been introduced per urethram. Apparently any object of such shape and size as to permit its passage through the urethra may be found in the bladder. Filiforms and catheters are the most common instruments introduced by the physician and, through accident, portions of these may be left in the bladder. This accident attending the use of filiforms apparently occurred more commonly with the rigid, steel follower formerly used so generally. There was a tendency for the filiform to break just beyond the metal screw attachment to the rigid metal follower due to the acute bending at this point as the tip of the follower entered the bladder. With the flexible followers now in use there is much less danger of this accident. Even with these, however, there is always the danger of separation of the filiforms from the follower within the bladder at the time of withdrawal of the instrument if great care has not been exercised in using only instruments with perfectly fitting parts. The fine threads of both filiform and follower wear quickly and are not very durable. Hence they should be thoroughly and carefully tested each time before using and should be discarded if not in perfect condition.

Much more interesting but less common are those cases in which

the foreign body reaches the bladder by other routes; for example, by way of the ureters, through penetrating wounds and injuries, and by migrating from adjacent structures. While these cases are not rare they are by no means common. A considerable number of case reports are scattered through the literature, chiefly foreign. We have found relatively few in the American literature. The following classification based upon case reports compiled from the literature is useful in showing the interesting variety of objects recovered from the bladder and the manner in which these reach it.

I. Introduced through the urethra
   1. By the patient—chiefly females, frequently males
      (attempted abortion, masturbation, catheterization)
   2. By the physician for diagnosis and treatment
      (pieces of catheter, filiform, lithotrite, sound)

II. By way of the ureters

III. Following penetrating wounds and injuries
   1. Wounds by firearms
      (bullets, pieces of shrapnel)
   2. Crushing injuries of the pelvis
      (splinters of bone)
   3. Injuries from falls and impalement
      (bits of clothing, et cetera.)

IV. Migratory from adjacent structures
   1. Bone sequestra from caries of the pelvic girdle
   2. Firmer parts of dermoid cysts of the ovaries
   3. Parts of skeletal structures from extrauterine pregnancy
   4. From intestinal tract
      (a) fecoliths
      (b) intestinal contents through intestino-vesical fistula
      (c) migration by ulceration—objects swallowed
   5. From vagina
      (pessaries, drainage tubes)
   6. From distant structures
   7. Surgical accessories left in wound at operation
      (a) artery forceps
      (b) gauze sponges, tampons, and drains
      (c) drainage tubes
      (d) non-absorbable sutures and ligatures.

Foreign bodies reaching the bladder by way of the ureters are chiefly kidney calculi. Rarely the contents of an echinococcus cyst of the kidney escape through the ureters. Fritsche (quoted by Monaschkin) removed four gall stones from the bladder which were said to have reached the bladder by way of the right ureter which became attached to the gall bladder by inflammatory adhesions.

Following wounds and injuries.—It has been remarked how seldom the bladder is involved in injuries and wounds of the pelvis. This is notably true in war wounds. When such injury does occur it is frequently associated with injury to the bones of the pelvic girdle. Splinters of bone penetrate the bladder wall and form the nucleus of a bladder stone. Legueu found a calculus had thus formed in ten of thirty-two cases of bladder wounds. Bullets and pieces of shell have been recovered from the bladder, carried directly into its cavity, or, deposited in adjacent tissues, later penetrated its walls. A most unusual case is recorded by Legueu in which a projectile penetrating the patient's bladder carried with it a coin from the pocket of a soldier killed beside him. A stone with the *sou* as a nucleus was removed thirteen months after the injury. Lohnstein reports a case in which the patient fell astride a barbed wire fence. A long sharp barb penetrated the bladder carrying with it a bit of the patient's underwear which formed the nucleus of a stone removed later. A similar case was reported by Otis.

Migratory foreign bodies.—This group includes an astonishing variety of objects which penetrate the bladder wall by ulceration either with or without fistula formation. These may come from the intestinal tract, tubes, ovaries, appendix, vagina or more distant parts such as bone sequestra or solid objects introduced by accident (knife blade, reported by Judd; piece of fractured rib reported by Packard).

In a paper on the miration of foreign bodies from the abdominal cavity to the bladder Monaschkin (1926) collected thirty-six cases from the literature of the last thirty years and added one personal case. In five of these the foreign body perforated the bowel (splinter of wood, glass of rectal tube, incrusted bone, vegetable fibers and fecolith); fourteen followed abdominal operations

(hemostats, silk ligatures, gauze sponges, gall stones, pessary); one resulted from extra-uterine pregnancy (parts of skeleton); one followed herniotomy (gauze sponge); twelve from wounds and injuries (bits of cloth, projectile, bone splinters, pieces of shell); in three cases the objects (hairpin, needles, procentaræometer) were alleged to have been swallowed. The author expressed doubt on this point and believes they probably were used for sexual purposes. In his own case a calculus had formed about a coiled double drainage tube. According to the history a vaginal incision for an abscess in Douglas' pouch with tube drainage was made in 1914 in Switzerland. At the outbreak of war a hasty departure prevented removal of the drainage tube which afterward wandered to the bladder. "C'est la guerre."

In this group of migratory foreign bodies the most interesting and certainly the most important because preventable are surgical accessories left in the wound at operation. A most unusual case is reported by Stoeckel (1907) (quoted by Monaschkin) in which an artery clamp was left in the wound. There were no symptoms for six months, then sudden onset of bladder symptoms with hematuria. The forceps was felt through the vagina and seen by cystoscopy. It lay one-third within the bladder, two-thirds retrovesical and encapsulated. Removal was effected by the vaginal route.

According to Petrén, Hinterstroisser collected 125 cases of gauze sponges and tampons left in the abdomen at operation. In six of these the foreign body found its way into the bladder. Interesting cases are reported by LaRoque (1919) and Alan Wood (1930). In LaRoque's case a sponge left in the pelvis five years before remained symptomless up to ten days before admission to the hospital, at which time agonizing symptoms of cystitis developed. Nine days after admission a piece of gauze presented at the meatus. By traction a strip 2 inches wide and 10 inches long was delivered. Six days later all symptoms had subsided and the patient was well. In Wood's case a piece of gauze was left in the depths of a herniotomy wound, where it remained for ten years. During eight years the patient experienced only slight pain in the lower abdomen and over the sacrum. The pain grew gradually worse during the next two years, at the end of which time the patient developed acute bladder symptoms. At operation a gauze sponge was found lying

mostly outside the bladder with a portion projecting through an opening in the right lateral wall.

We had an opportunity of observing a patient with a migratory foreign body in the bladder, an encrusted silk ligature. This ligature had been employed in an operation upon the uterus twenty-three months before. This case seems to us worth reporting in some detail as follows:

REPORT OF CASE

Miss R. W. C., forty-three years of age, engaged in secretarial work, was referred to us May 13, 1930, complaining of "bladder trouble." She had been unusually healthy up to two years ago. At that time a lump appeared in her breast following a fall against the sharp edge of a table. This breast was amputated in January, 1928. The pathologic diagnosis was cyst, non-malignant.

During the following year she suffered with marked loss of blood at her menstrual periods. A pelvic examination failed to show any pathologic lesion. Secondary anemia became pronounced with hemoglobin of only 30. She was given injections of iron for her anemia with definite improvement. Ill in bed from weakness she was finally sent to the hospital for an operation upon the uterus. We have been unable to learn the details of this operation performed in May, 1929. Suppuration of the wound occurred. She was in the hospital four weeks and was discharged before healing of the wound was complete.

Previous to her pelvic operation she had never had any symptoms referable to the bladder or intestinal tract. Immediately following this operation she had "colitis" and shortly afterward "cystitis" developed. She suffered pain in the bladder when voiding and with defecation. Frequency of urination was marked. After healing of the wound she had a fever to 104. At this time her symptoms of cystitis were severe. There were no symptoms referable to the kidney. Pain was referred to the lower abdomen, to the back and the epigastrium. While in the hospital she received bladder irrigations for her cystitis. Pus and blood in the urine were noted shortly after operation and have persisted to the present.

She was sent to the country to recuperate but remained only two days on account of a recurrence of her high fever. In early July she went to her home in Nebraska, spending a day in a hospital in Chicago on the way. Her family physician sent her to Omaha for an X-ray examination of the intestinal tract. This examination disclosed a spastic colon. She was given injections of iron and strychnine and electrical massage of the colon was advised. She was able to take only a few of these treatments as the effort was too much of a tax on her strength.

She returned to Washington in August, 1929, received more injections of iron and internal treatment for her cystitis. During the following months she had intermittent attacks of fever, suffered constantly with frequent painful urination; the urine was always cloudy and at times frankly bloody. She was bravely trying to carry on with her work with indifferent success, her complaints receiving little serious consideration by her medical advisers.

Examination, May 13, 1930, showed a somewhat obese, young looking woman apparently in good general physical condition except for anemia. Abdominal examination was not satisfactory on account of the size and thickness of the abdominal wall. There was no mass or rigidity. There was a tender area in the lower left quadrant just above the pubis.

External genitalia were normal. A catheter was passed and turbid urine obtained containing one large fleshy blood stained shred, acid, negative for sugar, a heavy ring of albumin. Smear showed numerous pus and red blood cells. There were no organisms in the stained smear. Examination for tubercle bacilli was negative.

On cystoscopic examination a tumor mass was seen behind the trigone and to the left of the mid-line. This was made up of a series of bullous growth arising from a central stock or localized area of the bladder wall. The appearance was not unlike that of a bunch of green grapes. The mucosal covering in places was pinkish in color. The bladder capacity was small. The tumor mass appeared extensive. The remainder of the bladder wall, however, was normal. The ureteral orifices were identified and were normal.

We advised fulguration of this peculiar bladder growth. The patient, however, strongly urged operation in the hope of immediate relief from her long continued suffering and for personal reasons connected with her work. On admission to the hospital, routine examination was negative except for apparent lesion in the urinary tract. The blood chemistry was normal: Non-protein nitrogen 35 and creatinin 1.3. Hemoglobin was 64 per cent. The uterus had been removed. The bladder wall seemed to be definitely thickened on vaginal examination.

Operation was performed May 29, 1930, under spinal anesthesia. An incision was made through the scar of the previous operation. The bladder was thickened and tucked down behind the symphysis. The peritoneum was accidentally opened. Exploration with the finger showed a thickened contracted bladder firmly fixed in its position deep in the pelvis, probably a result, it was thought, of her pelvic operation. Closing the peritoneum, the bladder was opened as widely as possible. The wall was thickened and the cavity markedly reduced. The posterior wall appeared to be covered by a growth made up of a series of bullous clubbed villi resting upon a markedly thickened bladder wall. On account of our inability to mobolize the bladder

without extensive dissection and the apparent wide area of bladder surface involved, resection was for us quite impossible.

After excision of a specimen for pathologic examination the growth was thoroughly fulgurated and cauterized. The bladder was closed tightly with urethral Pezzer catheter drainage.

The patient was perfectly comfortable during her convalescence in the hospital. The catheter was removed on the twelfth day. There was no leakage through the wound. She returned to work on the nineteenth day.

The pathologic report from the cancer registry was as follows: "A squamous cell carcinoma of Group 3 malignancy infiltrating the bladder wall. There is no papillary feature evident in the histologic material. In the larger cell groups there is a tendency to adenomatous arrangement."

When seen one month after discharge from the hospital the patient complained of considerable urgency but no pain on voiding or other discomfort. She was working every day and looked and felt fine except for the bladder trouble noted.

The following note was made September 27, 1930, four months after operation: "Patient looks and feels wonderful except she still has blood in the urine and occasionally sharp pain and tenderness over the lower left quadrant. Scar from the operation wound is solid. Cystoscopy under nupercaine anesthesia was without discomfort except from distention of the bladder. The bladder is entirely free except an area far back on the base and slightly to the right of the mid-line which shows essentially the same picture described at our first cystoscopy; namely, a series of bleb-like bodies springing from a central area of the bladder wall. In some places these have a pinkish color; in others they look like small serous cysts. The picture is not unlike that seen in cases of inflammation or new growth of the adnexa which has extended to and involved the bladder wall with resulting changes in the overlying bladder mucosa. The picture certainly differs from that seen in ordinary papilloma of the bladder. It also differs in appearance from that seen in sessile carcinoma of the bladder. The pathologic report shows that it is a squamous cell carcinoma of Grade 3 malignancy." Fulguration under spinal anesthesia was advised.

Two weeks later extensive fulguration was carried out. At this time the "tumor" appeared to be made up of multiple bullous masses about the color of green grapes. It was noted that when the fulgurating wire was placed against the base of the growth this appeared to be rather dense and firm, giving the impression of infiltration of the bladder wall. For this reason it seemed probable that the implantation of radon seeds at a subsequent sitting would be advisable.

Our next cystoscopy was made two months later, December 12, 1930. The bladder was clear except for a small circumscribed area far back in the fold of the bladder covered by several small nodules having the appearance of small pimples. A small slough was attached to the

upper edge of this area. This was an amazing change in appearance compared with that before fulguration. During all this time the patient was measurably comfortable, worked every day, felt very "peppy" and well. Laboring under the impression that we were dealing with bladder carcinoma which appeared to be kept in check and gradually clearing up we advised further fulguration, which was done January 20, 1931, under spinal anesthesia.

During the following six weeks the patient complained of a good deal of bladder irritation—frequency and pain after voiding. The urine was constantly tinged with blood and contained a considerable pussy sediment. She was given bladder irrigations followed by sedative instillations. Another cystoscopy at this time, March 10, 1931, showed a small slough at the site previously noted, covered with phosphatic incrustations. This area was exquisitely sensitive and painful. Her symptoms of bladder irritation became more pronounced. She voided considerable quantities of gritty material accompanied by a good deal of pain but followed by marked relief of symptoms. Just at the time when we appeared to be making progress in clearing up the bladder growth this new complication arose to discourage us and increase the patient's discomfort. She remained cheerful, however, and believed she would ultimately get perfectly well. We could not share her optimism.

Her discomfort finally became so acute that an attempt was made, under spinal anesthesia, to remove as much of the phosphatic incrustations as possible with the cystoscopic rongeur. We found the slough firmly adherent and impossible to detach. It was grasped in the bite of the instrument and traction made, but we were afraid of tearing the bladder wall. We crushed and removed a considerable quantity of the calcareous material (March 21, 1931). It appeared that we were dealing with a sloughing tumor of the bladder wall impregnated with hard, gritty phosphatic material. There seemed to be little hope of relieving the condition except by opening the bladder again, removing the slough and planting radium seeds. Following this the patient had an uncomfortable time with marked frequency, urgency and pain on voiding aggravated by the passage of the hard gritty material.

In view of subsequent developments the exact dates are now important. The next visit was six days later, March 27, 1931. She had had an uncomfortable week following the attempted removal of the slough. Bladder symptoms were severe but she had passed no appreciable amount of gravel. The urine was bloody and contained much pus. Calcareous material could be felt with a silk catheter in the bladder. Bladder irrigation was following by an injection of silvol in nupercaine. For the first time she was compelled to take a tablet of codeine while at her work to relieve bladder pain. At her next visit, April 6, 1931, she stated that she had passed a large piece of calcareous material the day before followed by considerable relief of acute symptoms. We were able to detect more of the same material

in the bladder with the silk catheter. Irrigation of the bladder was very painful. Open operation appeared imminent for the relief of the severe symptoms. On the following day, April 7, 1931, the catheter was obstructed in the urethra on attempting catheterization. Retracting the lips of the meatus what appeared to be a stone was seen in the urethra. This was grasped by thumb forceps, crushed easily and several small fragments were removed. Grasping another bit of the stone it appeared to be attached to something which gave slightly on traction. We were able to bring this fragment outside the meatus by gentle but firm traction and discovered that it was attached to what appeared to be a shred of tissue covered by phosphatic incrustations. We thought a part of the slough previously seen on cystoscopy had separated from the bladder wall and had caught in the urethra during urination. Considerable traction was made in an effort to release and extract this supposed slough, but we were unsuccessful. A pair of scissors was then carefully introduced within the meatus and the strand of tissue cut across. We were surprised to note how firmly this cut, quite unusual for a bit of sloughing tissue. The strand of material thus removed was fully an inch and a half long and was completely covered by hard, gritty calcareous crystalline deposit. Washing off this desposit we discovered that our supposed slough was in reality a bit of string resembling a piece of ordinary twine. This was formed into a small complete loop by a surgeon's knot. This loop was about 2.5 mm. in diameter.

For the first time we began to understand the nature and probable cause of our patient's trouble. It seemed most probable that this was a piece of heavy non-absorbable suture material used in the pelvic operation in 1929, a mass ligature employed to control hemorrhage; that this suture had ulcerated through the bladder wall and was just appearing in the bladder cavity where it became quickly covered with the phosphatic material. It was evidently long enough to allow the free end to extend into the urethra with the efforts of the bladder to rid itself of the foreign body during the act of urination. It was also evident that a considerable part of the ligature still remained in the bladder. It was still a question whether or not the remainder was entirely free in the bladder or was partly embedded in the bladder wall or the perivesical tissues. However, immediately following the removal of the small section of ligature the patient was immeasurably more comfortable. She slept for four hours, something she had not done for quite a year. Two weeks later she again began to suffer with marked frequency and pain on voiding due, apparently, to the foreign body in the bladder crowding down into the urethral outlet. On April 29, 1931, under spinal anesthesia we could see at cystoscopy a long piece of suture lying on the bladder floor with one end apparently attached to the bladder wall well up on the posterior surface. With a pair of cystoscopic forceps this was grasped near its attachment to the bladder and easily detached. The free end presented quite

a globular enlargement, the whole heavily encrusted. Withdrawing the forceps until the jaws, still grasping the end of the suture, were at the fenestrum of the cystoscope, the instrument and the forceps were removed together from the bladder thus dragging the end of the suture outside the meatus where it was grasped by a pair of hemostats. By firm traction on the suture and at the same time pushing back the lips of the meatus, first on one side and then on the other, the bulbous end of the suture was finally delivered. Immediate cystoscopy showed the bladder free except for some phosphatic detritus on the bladder floor. The patient returned to work the following day and has been completely relieved of all her bladder symptoms.

The second section of suture removed was similar to the first and about 4.5 inches in length. It contained two loops, the larger one at the end completely encrusted, which accounted for the bulbous enlargement. This was a most extraordinary ligature to employ and doubtless indicates excessive hemorrhage at the operation and a determined effort to control it.

In view of the unexpected happy outcome in this case we suggested a review of the slides by the pathologist to whom the material was sent for histologic study. The following note explains itself: "It appears to us that the degree of malignancy reported to you was too high for the type of cells present, but they were located in new-formed fibrous tissue, and appeared to be separated from any contact with the surface of the material submitted. It was, therefore, considered from the appearance that these cells in fact were separated and represented an invasion of epithelium. This may still be the case, but it is also possible that the bladder was injured during the operation for removal of the uterus and that the growth represented granulation tissue which had included masses of proliferating epithelium in the course of the healing process."

COMMENT

In reviewing our experience in this case we are impressed with the fact that the bladder symptoms developed immediately after the operation on the uterus and persisted in a mild form, gradually getting worse during the following year. At our first examination the peculiar appearance of the bladder changes were noted but their significance was not appreciated. These were thought to represent an unusual form of bladder tumor. With the bladder opened, direct inspection did not arouse our suspicions, and the pathologist's report confirmed us in the belief that we were dealing with a new growth. It was four months after our operation that we noted at the first postoperative cystoscopic examination that the "recur-

rence" presented a picture suggestive of perivesical inflammation. A thorough fulguration was done and a check-up two months later by the cystoscope showed only a small slough surrounded by several small nodules of inflammatory tissue. The same condition was observed five weeks later when a second fulguration was done, January 20, 1931, following which the patient was only fairly comfortable. It was six weeks later that calculous material was first seen covering the slough and only a month previous to the removal of the ligature from the bladder. In other words, the migration of the ligature through the bladder wall appears to have been a relatively rapid process. Likewise the deposit of calcareous material was very rapid, favored, no doubt, by the large quantity of purulent sediment in the urine. This deposit began apparently soon after exposure of the end of the ligature within the bladder and continued as it gradually worked its way into the cavity. The clinical course in this case differs in one important respect from other similar cases reported in the literature in that the bladder symptoms came on immediately after operation and were persistent. In most of the reported cases there was an interval between the pelvic operation and the onset of bladder symptoms.

The first case of incrusted suture found in the bladder is said to have been described by v. Mandoch, in 1882. Nitze was probably the first to observe with the cystoscope a silk ligature which had migrated to the bladder following a gynecologic operation. In this contribution (1887) entitled Beiträge zur Endoskopsie der Männlichen Harnblase, he describes the case of a *female* operated upon two years before for an ovarian tumor. The pedicle was ligated with silk. Twenty-two months later she developed bladder symptoms associated with chills and fever which confined her to bed for four weeks. She had been symptomless in the interval between her operation and the onset of cystitis. Five months after the onset of cystitis a stone was detected in the bladder and a portion removed by lithotrity, after which a piece of silk thread was voided. Three weeks later she was seen by Nitze, who removed some more calculous material followed by the passage of another piece of thread. The next day at another session with the lithotrite something was grasped in the jaws which appeared to be fixed to the bladder wall. By firm traction the instrument was suddenly freed and on withdrawal contained in its grasp a piece of ligature looped

and tied with a surgeon's knot. This gave for the first time a clue to the whole story: a silk ligature used in the operation twenty-seven months before had migrated to the bladder cavity and become incrusted by a calcareous deposit. A subsequent cystoscopy showed two free ends of a ligature projecting into the bladder with the remainder embedded in a small reddened cone-shaped elevation of the mucosa. This case is referred to in some detail because of its historical interest and the fact that, as in our own case, the recovery from the bladder of a silk thread which one could identify as a ligature by a knotted loop gave the first clue to the nature of the condition under treatment and its exact etiology. A very good illustration of the cystoscopic appearance in this case accompanies the paper (Tafel viii, No. 2).

Similar observations were made by v. Dittel (1891) and Samter (1893) who reported six cases from Posner's clinic, all following gynecologic operations. After this period it was generally recognized that buried silk sutures and ligatures when employed in the pelvis might cause bladder trouble later.

Stoeckel (1914) declared that "so long as gynecologists especially use silk for ligatures and sutures these can appear later in the bladder, not only when they penetrate the bladder wall itself but also in operations carried out in the vicnity of the bladder, chiefly vaginofixation. Moreover, this complication has been observed after other operations, especially after supravaginal amputation of the uterus and operations on the adnexa, in short after any operation where non-absorbable sutures are buried in the neighborhood of the bladder." Legueu (1900) writes, "Since gynecologic operations are increasing in number one observes more often . . . silk threads, used for ligation of the pedicle, penetrating the bladder where they form the nucleus of a stone." Casper's experience indicates this is not an uncommon complication. He states, "I have repeatedly found silk ligatures with and without incrustations in the bladder and have removed them by cystoscopic forceps." However, one finds only a relatively few cases of this kind reported in the literature of the past ten years. This is probably explained in large part by the fact that absorbable suture material has largely replaced silk in surgery, especially in gynecologic operations. It is also probable that many cases are not reported.

Petrén (1930) reported three cases, one following a herniotomy.

Other cases following herniotomy are reported by Nossal (1903), Young (1909), and Chute (1915). H. P. Winsbury White (1930) reports two cases following cesarean section: in one the stones and sutures were passed spontaneously, in the other they were removed by cystotomy. Baldwin's case (1931) is interesting in that the number of sutures used in an operation in the pelvis "many years ago" was accurately recorded at the time of operation. Later, vesical calculi, each formed about a suture, were passed by the patient at intervals during the next year until every suture was accounted for in this way.

The interval between the operation and the onset of bladder symptoms varies widely in the reported cases, from six months (Samter) to four years (Petrén). If the suture penetrates the bladder wall at the time of operation bladder symptoms develop immediately (Nossal), otherwise months or even years may elapse before the onset of cystitis denotes the development of this complication. This interval is usually symptomless. Symptoms of vesical irritation develop with the beginning of the migration and persist more or less acutely until the bladder is free of the foreign body. Why a non-absorbable ligature which has remained quiescent for years in the tissues about the bladder should finally become restless and start wandering through the bladder wall and into the vesical cavity is not altogether clear. It is apparently just another illustration of the intolerance of the body tissues to the presence of a foreign body. The actual process is probably always associated with and initiated by the advent of infection. The presence of the foreign body invites infection. In many cases operation has been carried out in infected tissues; in some, infection unquestionably occurred at operation. The clinical history suggests this, as in our case. In other cases recovery from the operation was prompt and uneventful, relief of symptoms followed and nothing in the clinical history suggests deep seated infection. One must suppose that here the irritation of the foreign body never completely subsides although symptomless, and eventually infection occurs, an abscess forms, and wandering of the foreign body begins. Migration through the bladder wall inevitably produces symptoms which promptly call for relief. It is not altogether improbable that such a foreign body at times migrates into the bowel and is extruded without giving rise to symptoms which are recognized or correctly

interpreted. But this is only an hypothesis difficult to prove or disprove. In earlier days when silk ties and ligatures were generally used it was no uncommon experience to see long after operation one or more sutures extruded from the wound through a small fester developing in the incision. This was interpreted as evidence of irritation produced by the foreign body.

In the bladder a foreign body sooner or later becomes incrusted with urinary salts. This occurs much more rapidly in some cases than in others. Migratory silk sutures on reaching the bladder cavity rapidly become incrusted and often form the nucleus of a stone. Large ligatures thus incrusted as in our case cause such acute symptoms as to demand immediate relief. Smaller sutures may remain fixed to the bladder wall for a long time while a calculus of considerable size forms about the free end. Such calculi may become detached and passed spontaneously (Baldwin, White) or remain attached to the bladder wall and ultimately removed by endo-urethral or open operation. When suspended from the dome of the bladder they form "hanging stones" (Young, White, Petrén, Attow).

DIAGNOSIS

The diagnosis of migratory silk sutures in the bladder is not so simple or easy as one might suppose. In the first place the condition occurs so seldom that one does not usually suspect it. The symptoms of acute cystitis—marked frequency, urgency, dysuria, associated with pyuria and hematuria—may occur at the outset during its passage through the bladder wall. Before the suture reaches the mucous surface cystoscopy usually reveals marked changes in the overlying mucous membrane characterized by a bullous edema and circumscribed nodular elevations composed of granulation tissue. In our case the significance of these changes was not at first appreciated. These may be mistaken for a tumor.

Having reached the bladder cavity the silk thread becomes so rapidly incrusted with salts that the character of the foreign body can seldom be made out. Rarely can one follow by cystoscopy the process of migration with the accompanying changes in the mucosa as reported by Lohnstein and Kielleuthner. Exceptionally, however, the frayed out end of a suture may be identified on cystoscopic examination as in Case 2 reported by Petrén. The stone forming about a suture may be mistaken for an incrusted tumor (Knorr).

A hanging stone readily suggests a suture as the nucleus. Attow suggests that since vesical calculi in women are so relatively uncommon, in all cases of proven stone in a female bladder or stone-like structures the possibility of a foreign body must be considered.

TREATMENT

The treatment of this condition requires little discussion. Spontaneous passage of the ligature or the stone forming about it may occur. Otherwise the foreign body must be removed. This is often accomplished by the cystoscopic rongeur. It will occasionally happen that for one reason or another one must resort to an open operation.

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The following cases of ligatures and sponges in the bladder are compiled from the reports of Monaschkin and Petrén to which have been added a few additional cases found in the literature. A complete search of the literature has not been made.

Ligature in the bladder.—Nitze (1887); v. Dittel (1891); Samter (1893) six cases; Leopold (1907); Sénechal (1908); Young (1909) quoted by Wood; Le Fur (1910); Haeber (1911); Mayer (1911); Knorr (1912); Gradjahr (1913); A. L. Chute (1915); Petrén (1930) three cases; H. P. W. White (1930) two cases; Baldwin (1931).

Sponges in the bladder.—Stoeckel (1907); Rovsing (1910); Kermanner (1912); Stoeckel (1914); LaRoque (1919; Ellerbrock (1922).

After herniotomy.—Subbotic; Wood (1930).

RESECTION OF THE PRESACRAL NERVE FOR DISEASE OF THE BLADDER: EXPERIENCE IN TWENTY-FOUR CASES

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This is a welcome opportunity of recording our experience of resection of the presacral nerve in the treatment of disease of the bladder. Few surgical measures are so thoroughly established that their advocates do not benefit from their critical discussion by surgeons of experience; moreover, this operation represents an overlapping of two fields of surgical specialization, and like all such it can be strengthened and clarified by cross-fertilization of slightly different points of view. The operation has been performed in twenty-four cases of vesical disease, without any mortality. It will be convenient to consider the cases under three headings: (1) vesical paralysis (eight cases); (2) vesical pain (twelve cases), and (3) obscure obstruction at the neck of the bladder (four cases).

From time to time, as we have learned more about these conditions, we have found that we had labelled individual cases wrongly, and the groups given above cannot yet be regarded as exact. In the same way the passage of time has modified results, so that in some cases initial improvement has not been maintained, whereas in others improvement has been so slow that some originally disappointing cases have proved, in the long run, to have made satisfactory progress. Finally, we have made mistakes in diagnosis and in treatment, obvious enough in retrospect but not recognized originally; fortunately, none of these has had any untoward effect.

PARALYSIS OF THE BLADDER

We have already stated the principles governing the selection for operation on the presacral nerve of patients suffering from paralysis of the bladder; they may be quoted from our original

paper: "The clinical data must point to reduction of the function of the pelvic nerves (aptly called by Rose the 'emptying' nerves of the bladder), while the hypogastric nerves are uninjured; in other words, the balance of vesical innervation is disturbed, and injured pelvic nerves are handicapped in their task by the 'brake' action of intact hypogastric nerves. As a corollary, there must not be total paralysis of the pelvic nerves, in order that after removal of the brake the residual expulsive power of the detrusor muscle may be more equal to emptying the bladder. Again, the patient must be continent, through the action of the external sphincter muscle, for the hypogastric nerves are the motor nerves to the internal sphincter. Finally, there must be satisfactory renal function." In this hypothesis of the functions of the vesical nerves there is a physiologic assumption for which we have not, as yet, conclusive proof in the human being. This assumption is that the inhibitory action of the thoracicolumbar sympathetic outflow is being constantly applied to the musculature of the bladder during the act of micturition; it is at least possible that these nerves exercise their effects only during filling of the bladder.

Case 1.—A man, aged thirty-six years, had an acute infectious process involving the second, third, fourth and fifth sacral segments of the spinal cord; in short, the segments which supply motor, sensory, and reflex parasympathetic fibers to the bladder. Fourteen months after the onset he came to The Mayo Clinic complaining of inability completely to empty the bladder; even in the sitting posture it could be only partly emptied.

On cystoscopic examination 270 c.c. of residual urine was found, and anesthesia and loss of expulsive force were noted. The neurologic diagnosis was residual myelitis of the conus, and the opinion was expressed that the injury to the cord was permanent. In the hope of restoring the emptying power of the bladder and thus of avoiding pyelonephritis, resection of the presacral (or sympathetic) nerve was advised and was accepted. Following a convalescence complicated by severe epididymitis, the amount of residual urine decreased and finally disappeared. Two months after operation the patient was able to empty his bladder completely, although he still used the sitting posture. After his dismissal, the expulsive power of the bladder improved so that he could empty it in the standing posture, and repeated checks, made elsewhere, showed that residual urine was not present.

A year after operation, the patient was reëxamined at the clinic. The greatest amount of residual urine found at any test was 20 c.c. He emptied his bladder in the erect posture, with some help from the

abdominal muscles in starting the flow. A urogram made by the intravenous method showed that the pelves and calices were not dilated; there was some dilatation of the lower segments of both ureters. The man had improved greatly in general health, in spite of the fact that in the interval he had been much exposed to cold and wet. As had been foretold, the neurologic signs were the same as at the first examination.

Two years and four months after operation, a letter from the patient informed us that he was in excellent health, had not any residual urine, and that the urine contained six pus cells in each high power microscopic field.

Comment.—As we have pointed out elsewhere, the continuous drainage of the bladder during the convalescence of this patient is a complicating factor in assessing the amount of benefit directly derived from the neurectomy. This factor was absent in Case 2.

Case 2.—A boy, aged eight years, was brought to The Mayo Clinic because for five years he had required catheterization three times a day. At the age of three years he had become so ataxic and weak in the legs, that he had been unable to walk for three months. This illness was accompanied by retention of urine, which had persisted, although power to walk had returned. From a neurologic standpoint there was no somatic evidence of his previous illness. He could pass but little urine voluntarily, and he was unable to tell when his bladder was full, so that he regularly wet his bed. Four years before operation, a week's residual urine averaged 1,840 c.c.; immediately before operation this amount had increased to 2,640 c.c. A cystometrogram showed a large atonic bladder.

After resection of the presacral nerve, the patient's progress to recovery was uneventful. The first week after leaving hospital, the residual urine totalled 178 c.c. For some time we insisted on daily catheterization at home, lest unnoticed overdistention of the bladder should undo the postoperative improvement. Eight months after operation, the patient was being catheterized once a week, and the highest amount of residual urine drawn off was 12 c.c. The boy could micturate on request, knew when his bladder was full, and never wet his bed.* Great credit for our patient's assiduous postoperative care is due to his family physician and to his mother.

A report from the boy's mother, two years after his operation, stated that the residual urine was still measured at the end of each month, and that it did not amount to more than 4 to 8 c.c. Some urinary infection was still present.†

*This is an interesting contrast with the case reported by Riddoch. As a result of a gunshot wound of the spinal cord, Riddoch's patient was left with only the sympathetic (presacral) nerve connecting his bladder with the central nervous system; however, he knew when his bladder was full.

†Measures will be taken to control this by a ketogenic diet.

Case 3.—An unmarried woman, aged forty years, had had bilateral pyelectasis and ureterectasis for twenty-five years, as a result of incomplete emptying of the bladder. The process was probably of congenital origin. It declared itself in periodic attacks of fever, chills, and difficulty in urinating; during these attacks, a large amount of residual urine was present. On cystoscopic examination, in addition to the inevitable cystitis, the ureters were found to enter the dilated bladder in such an oblique fashion as to cause obstruction to the downflow of urine.

Operation was undertaken in this case, in an endeavor to improve the expulsive force of the bladder. In this it was successful, for Dr. D. K. Rose of St. Louis, to whose care the patient returned, found that the capacity of the bladder had been diminished, and its expulsive power increased. Twelve months after operation, residual urine was still absent.

Comment.—It cannot be claimed that this patient's condition has been changed for the better. She still suffers occasionally from chills and fever, and the advisability of bilateral nephrostomy is being considered. We are of the opinion that in the future it will be possible to control dilatation of the ureters and pelves due to neuromuscular dysfunction by suitably planned operations on nerves, but whether such an operation should be contemplated in the presence of a tortuous chronically inflamed ureter is very doubtful.

Case 4.—A women, aged forty-eight years, nine years previously had attempted to produce abortion by instruments and by drugs; immediately thereafter she became unable to empty her bladder. Since that time she suffered from intermittent chills and fever, dealt with at intervals by a retention catheter and the forcing of fluids. Six months previously, suprapubic exploration had been carried out (elsewhere) because of suspected carcinoma of the bladder, and this operation had been followed by some improvement. Neurologic examination was negative. At the cystoscopic examination, a large amount of residual urine was found, with pronounced diminution in sensation and loss of expulsive force; the bladder was heavily infected. A urogram made by the intravenous route showed dilatation of the pelvis and ureter on the left side, whereas the right pelvis and ureter seemed normal.

The presacral nerve was divided, but the operation did not appear to affect the expulsive force of the bladder in any way, and at present the patient has remained unimproved for eight months.

Comment.—There appears to be a direct relationship between the attempt to produce abortion and the paralysis of the bladder,

and it seems to us that the most likely explanation is that the unskillful instrumentation was followed by sclerosing pericystitis. This case was of long standing and therefore not so favorable for correction, because, without doubt, many of the changes in the wall of the bladder were permanent. However, it may be pointed out that a most gratifying result followed the operation in Case 7, in which the etiology was similar.

Case 5.—A youth, aged twenty years, had had trouble with urination for two years; apparently, the difficulty was a sequel of an attack of scarlet fever. He had to strain to start the stream and had episodes characterized by chills and fever. At the urologic examination, a typical "cord bladder" was found, with 240 c.c. residual urine. As a roentgenogram showed a notch in the arch of the first sacral vertebra, this region was first explored; evidence of compression of the cauda equina was not found. Five days later the presacral nerve was resected. A month after operation, there was 20 c.c. of residual urine, and the expulsive force of the bladder was improved.

Comment.—We have been inclined, when confronted with a case of vesical paralysis, to advise preliminary exploration of the sacral spine if there was the slightest doubt of the normality of the bones in this region. In a certain group of cases, paralytic conditions of the bladder are associated with bony defects in the lumbosacral region. Sometimes these defects are part of an expression of general maldevelopment, for they are accompanied by unmistakable signs of central nervous defect. In other cases, the bony defect marks the site of a local agent which compresses the roots of the cauda equina, and in many of these cases no somatic evidence of a neurogenic defect can be obtained. Among the local compressing agents are fibrofatty tumors, cartilaginous bands, meningoceles, and bony spurs; the removal of these leads, in a favorable case, to restoration of vesical function. We have been disappointed with the extradural injection of lipiodol as a method of demonstrating spinal compression in these cases. It is true that often the laminectomy exposes the patient to an additional and unnecessary operation, but we have had such satisfactory results in a proportion of cases (50 per cent) that we hesitate to advise abdominal exploration before clearing up any obscurity with regard to the sacral canal. In the present case, at the exploration of the vertebræ, it was apparent at once that a compressing agent was not present,

for the dural sac pulsated normally. The result of presacral neurectomy in this case was not encouraging. We have the impression, although we have not any anatomic evidence for it, that the patient suffered from a rather rapidly progressive neuronitis affecting the intramural plexus in the bladder. In such a case, the prognosis is of course less favorable, because in order to insure improvement after presacral neurectomy, some power must remain in the neuromuscular mechanism of the bladder. This boy would possibly be better off either with a permanent suprapubic drain or with the ureters transplanted into the colon, but we have been unable to get in touch with him.

Case 6.—A man, aged twenty-eight years, had had nocturnal enuresis until he was aged seventeen years. For eighteen years he had had frequency and occasional burning on micturition, and for four years he had had attacks of pain, like those of renal colic, in the left loin. On cystoscopic examination, he was found to have a typical cord bladder, with residual urine which varied in amount from 50 to 210 c.c.

The region of the cauda equina was first explored, and a firm fibrocartilaginous band at the level of the first sacral vertebra was dissected off the dural sac. This procedure afforded the patient little if any relief, and seven months later he returned for resection of the presacral nerve. Reëxamination at this time showed that the amount of residual urine was about 120 c.c. One month after presacral neurectomy the residual urine measured 20 c.c., and the expulsive power of the bladder was improved. A year later, it measured 60 c.c., the expulsive power of the bladder was much improved, and sensation seemed to be more acute. We considered that the persistence of residual urine might be due to a bilateral intra-urethral enlargement of the prostate gland, which had, indeed, been noted at the first examination, but which had not been sufficiently emphasized. Accordingly, this was corrected by a punch operation, and at the same time the prominent ridge formed by the posterior border of the internal sphincter was planed away, so that there was an unobstructed passage from the verumontanum to the interureteric ridge. The tissue removed from the passage proved to be the usual hypertrophic adenofibroma. A month after this operation, on cystoscopic examination, the channel was wide open and the residual urine was estimated at from 10 to 20 c.c. There was still some cystitis at the base of the bladder.

We have been unable to communicate with the patient since.

Comment.—In retrospect, there seems to be no doubt that we allowed the evidence for neuromuscular dysfunction to weigh unduly in our minds in the diagnosis; the organic obstruction undoubt-

edly played a large part in producing the urinary stasis. No doubt, a certain instability of the neuromuscular mechanism was present, because this man had suffered for the first seventeen years of his life from nocturnal enuresis, and a developmental origin for the urinary difficulty was suggested by the presence of a duplicated pelvis on the right side. We incline to think that the prognosis for permanent relief is good. We ascribe to the presacral neurectomy a certain influence in increasing the expulsive power of the bladder. It is to be noted, however, that, together with the return of expulsive power, there was improvement in sensation; as the latter is not to be expected after presacral neurectomy, the recovery of the nervous mechanism may possibly have been independent of any of our interventions.

Case 7.—A married woman, aged thirty-five years, consulted us on account of inability to empty the bladder, which had been discovered during the course of an abdominal operation elsewhere. This disability had probably been present for fifteen months, and its beginning coincided with an attack of severe diarrhea during pregnancy. The patient was emaciated, and showed signs of marked urinary infection, with pain in the lumbar region and bouts of sharp fever. On cystoscopic examination, a cord bladder was found, with approximately 300 c.c. of residual urine. Expulsive force and sensation were both markedly diminished; however, an intravenous urogram showed that the upper part of the urinary tract was still within normal limits. Spina bifida occulta of the first sacral vertebra was present, and, in accordance with our practice, exploration of this area was advised first. At the level of the first sacral vertebra, a small firm band was found, below which the dura did not pulsate; after removal of this, normal pulsation returned. Although we had hoped that sufficient abnormality had been found to justify a favorable prognosis, the patient did not benefit from this operation. Therefore we advised presacral neurectomy.

The operation was performed a month later. When the abdomen was opened, adhesions were found between the omentum and anterior abdominal wall, and in the pelvis a chronic inflammatory process was present, involving the uterus, left tube and ovary, and the sigmoid colon. After this operation, there was marked improvement in the expulsive force of the bladder, and the patient's general health became much better. We had arranged for her to receive daily injections of acetylcholine at home, and while receiving these she was free from residual urine. Encouraged by the success of sphincterotomy in reducing the last remnant of residual urine in another case, we asked her to return to have this done, and six months after sphincterotomy, she was still free from residual urine. Her general health was greatly im-

proved in spite of the fact that she had undergone hysterectomy for metrorrhagia.

Comment.—The ultimate result in this case has been most gratifying from a social and an economic point of view, and we do not anticipate any return of the disability. We have frequently asked ourselves whether this result could have been obtained with fewer operations. We have already pointed out that exploration is the most reliable method of excluding a pathologic process under a spina bifida occulta; but we confess to mistaken optimism after the original operation in this case. When the abdomen was finally opened, the presence of the chronic pelvic inflammatory lesion led us to suspect local plexitis and neuritis as the underlying cause of the vesical paralysis; at once the question of the advisability of hysterectomy arose. We did not think it wise to combine the two procedures at one operation, and although it is possible that, if hysterectomy had been performed as the operation of choice, the vesical paralysis might have disappeared; in view of the severity of the paralysis, we felt that we should make every effort to restore function to the bladder. This the neurectomy succeeded in doing to almost a complete degree. We shall return to the question of sphincterotomy in these cases when we deal with physiology of the bladder after presacral neurectomy.

Case 8.—A man, aged twenty-two years, came to The Mayo Clinic on account of enuresis and infection of the urinary tract. On cystoscopic examination, he was found to have a typical cord bladder, with marked diminution of sensation, loss of expulsive force, and fine trabeculation. A cystogram showed a diverticulum in the left posterior wall, measuring 3 by 3 cm.; however, this emptied completely. A urogram showed normal pelves, kidneys and ureters on both sides. On inquiry, it was found that the enuresis had lasted since childhood, but that at the age of nine years, following an injury to the head, the patient had had an illness which was called "spinal meningitis." Neurologically there was little evidence of this, sensory changes being absent; however, there was some weakness of those muscles of the right leg supplied by the spinal segments from the fourth lumbar to the second sacral, and the tendon reflexes of these muscles were increased.

The sacral region of the spine was first explored, but no definite pathologic lesion was disclosed; four days later, the presacral nerve was divided. This operation seemed to be entirely without benefit, and, as a last hope, a sphincterotomy was performed, although there was little evidence that hypertrophy of the neck of the bladder played any part in the obstruction. None of these procedures benefited the

man, and at present he is leading a catheter life, with residual urine of 150 to 300 c.c.

These cases of paralysis (Cases 1 to 8 inclusive) are presented in abstract in Table 1 *a*, and the end-results are analyzed in Table 1 *b*.

TABLE 1 *a*. OUTLINE OF CASES OF PRESACRAL NEURECTOMY FOR PARALYSIS OF THE BLADDER

Age and sex	Cause of paralysis	Duration, years	Interval, months*	Comment
1. Resection of presacral nerve				
36M	Sacral myelitis	1⅙	28	Residual urine absent
8M	Lumbosacral myelitis	5	24	Residual urine absent
32F	Unknown	25	12	Residual urine absent but still dilatation of upper urinary tract with pain and much infection
48F	Unknown ("cord bladder")	9	6	No improvement
2. Exploration of spina bifida occulta plus resection of presacral nerve				
20M	Followed scarlet fever (residual urine 240 c.c.)	2	4	Residual urine 60 c.c. at last examination
3. Exploration of spina bifida occulta plus resection of presacral nerve plus sphincterotomy				
28M	Probably congenital lesion (residual urine 210 c.c.)	11	1	Residual urine 40 c.c. 1 year after presacral neurectomy; *absent* 1 month after sphincterotomy
35F	Chronic inflammatory pelvic lesion involving nerves to bladder	1¼	6	Still about 50 c.c. residual urine after presacral neurectomy, if acetylcholine not given; residual urine *absent* after sphincterotomy
22M	Cerebrospinal meningitis	13	5	Residual urine 150 to 300 c.c.; no improvement

*Time between last operation and last examination or report.

TABLE 1 *b*. END-RESULTS OF PRESACRAL NEURECTOMY AND COMBINED OPERATIONS FOR PARALYSIS OF THE BLADDER

Patients	8
Cases in which resection of presacral nerve improved the expulsive force of the bladder	5
Patients cured by section of presacral nerve alone	2
Patients cured by all procedures	4

VESICAL PAIN

Three neurologic operations are available for the relief of vesical pain: cordotomy or division of the pain tracts in the spinal cord, denervation of the bladder according to the method of Rochet, and division of the presacral nerve. The second is an operation of such difficulty and magnitude that it is seldom indicated. The first has a definite sphere of usefulness, its drawback being the occasional appearance of motor disability after the operation; in practised hands the risk of this complication is minimal, and Grant has recorded a series of cases successfully relieved by this procedure. Division of the presacral nerve has been much used on the Continent, especially by French surgeons, in the treatment of painful pelvic conditions. Its application to painful diseases of the bladder we owe to Pieri, who has also devised a more extensive operation to which attention has been drawn elsewhere.

We feel that it would be unprofitable to enter into any lengthy consideration of the mechanism of production of vesical pain, or of the paths by which it enters the central nervous system. Afferent fibers are undoubtedly present in the presacral nerve, for at operation stimulation of the nerve has given rise to localizable sensations of pain. Occasionally it is stated that the relief from pain which follows operations on the sympathetic system is to be ascribed to the improvement of nutrition which follows section of vasoconstrictor fibers in the nerves in question. Although this is undoubtedly a factor in chronic ulcerative conditions of a simple nature, the hypothesis is hardly sufficient to explain the relief of pain in malignant lesions.

NEURECTOMY LIMITED TO PRESACRAL NERVE

Case 9.—A man, aged forty years, had a history of urinary infection dating from the appearance, five years previously, of acute retention due to a urethral stricture. With the cystoscope, areas of interstitial cystitis were seen in the base of the bladder. Three weeks after operation, the appearance of the bladder was unaltered, although objective improvement was marked and showed itself in lessening of frequency and increased capacity. The patient still complained bitterly of pain during micturition, and when last heard from, eighteen months after operation, he stated that he had not had any relief.

Case 10.—A woman, aged thirty-five years, had had symptoms of interstitial cystitis for two years. The condition was diffuse, and the

capacity of the bladder was reduced to 90 c.c. Three weeks after operation, cystoscopic examination showed considerable improvement in the appearance of the bladder. Seven weeks after operation, the patient had a return of symptoms and since that time has had to have more or less continuous treatment. In a report seventeen months after operation, she stated that although there was some relief from the previous severe pain, she was still having considerable distress.

Case 11.—A man, aged fifty-nine years, had had symptoms of interstitial cystitis for fourteen years. Although the condition involved the whole bladder, it was most marked toward the right base. Improvement did not begin until a month after operation, when both pain and frequency were much reduced; sixteen months after operation, the patient stated that he was tolerably comfortable; there was never any severe pain, but occasionally there was some urinary irritation. His general health was much improved.

Case 12.—A woman, aged thirty-five years, had undergone nephrectomy for tuberculosis five years previously. Ever since the operation she had had frequency of micturition, with considerable pain felt in the neck of the bladder. The capacity of the bladder had been reduced to 200 c.c. On cystoscopic examination, several patches of areal cystitis were found throughout the bladder. The bacillus of tuberculosis was never isolated in the urine nor after inoculation of guinea pigs. The most marked improvement in this case was the disappearance of almost all the pain from which the patient had previously suffered, whereas the frequency was not correspondingly reduced, although it is not distressing except during very hot weather.

Case 13.—A woman, aged forty-seven years, had had symptoms of interstitial cystitis for nine years. The lesions were most marked in the upper part of the posterior wall. A month after the operation there was little change either in the appearance of the bladder or in the symptoms. Three months after operation the patient reported that she was almost well.

NEURECTOMY OF PRESACRAL NERVE WITH DIVISION OF PARAVERTEBRAL CHAINS AND SACRAL RAMI COMMUNICANTES (PIERI'S OPERATION)

Case 14.—A man, aged twenty-nine years, had had symptoms of interstitial cystitis and bilateral renal infection for six years. The infection of the upper part of the urinary tract was most marked on the right side, where the pelvis and upper ureter were dilated. The capacity of the bladder was reduced to 90 c.c. Operation gave transient relief only, although it was found easier to stretch the bladder so that it contained about 250 c.c. The improvement persisted for seven

months, after which it disappeared, and fourteen months after operation there had not been any further improvement.

Case 15.—A man, aged fifty-two years, had had suprapubic prostatectomy performed elsewhere two years previously. After this he suffered from painful and frequent micturition, the pain being localized about the neck of the bladder. On cystoscopic examination, marked scarring and infection of the prostatic bed were found, with chronic trigonitis. As a result of neurectomy, gradual and progressive relief of pain soon became apparent and at the same time the infection in the urine rapidly disappeared. Twelve months after operation, a report from him stated that he was extremely grateful for the relief which he had experienced.

Case 16.—A woman, aged thirty-nine years, had had symptoms of interstitial cystitis for one and a half years. On cystoscopic examination, the process was found to be most marked in the dome of the bladder, and toward the right side of the base. Ten months after operation, she had not experienced any relief.

Case 17.—A woman, aged fifty-eight years, had had symptoms of interstitial cystitis for six years. The capacity of the bladder had been reduced to 50 c.c., and cystoscopic examination showed interstitial cystitis which, although generally distributed, was especially severe over the base. After the operation, she was slow to obtain improvement, but a year later reported that she had not any pain in the bladder, but had considerable urethral irritation as the result of the growth of a caruncle. She was satisfied that the operation had been beneficial.

RESECTION OF PRESACRAL NERVE TOGETHER WITH OTHER MEASURES

Case 18.—A woman, aged twenty-nine years, had had symptoms of interstitial cystitis for six years. The process was most marked in the left base and posterior wall of the bladder. The pain was most marked in the left lower quadrant of the abdomen. After the usual urologic treatment had failed to give permanent relief, presacral neurectomy was performed. Cystoscopic examination after this did not reveal any improvement in the local condition, but for some months there was marked relief both of pain and of frequency. Ten months after sympathectomy, the capacity of the bladder was much increased and frequency was absent, but the patient complained of severe suprapubic pain when standing or walking. An irregular patch of interstitial cystitis confined to the left half of the dome of the bladder was found, and this area was resected by Dr. V. S. Counseller. Since then, an interval of ten months, she has been quite comfortable and has pursued her occupation.

Case 19.—A woman, aged fifty-seven years, had had symptoms of carcinoma of the bladder for five weeks. Through the cystoscope a

Grade 4 squamous celled epithelioma was identified; on rectal examination, it was found that there had been perivesical extension round the entrance of the left ureter into the bladder; the tumor was inoperable. The patient suffered severely from spasms which occurred both during and independently of micturition. After presacral neurectomy, she was almost completely relieved of this pain; three weeks later, she received a course of deep roentgen-ray treatment, and remained comfortable until her death seven months later.

Case 20.—A man, aged thirty-nine years, had had frequency of urination for nineteen years. There was no pain during micturition, but distress over the suprapubic area. Seven years previously, a diagnosis had been made of chronic prostatitis, chronic urethritis, and trigonitis, and the patient had had much treatment for these conditions, apparently without improvement. The condition was not gonococcal. Finally, in 1927, bilateral vesiculectomy was performed; this operation failed to improve his condition and he continued to complain of frequency and pain, especially nocturnal. In an effort to relieve the pain and spasm, presacral neurectomy was performed. The bladder was found to be covered with large varicose veins, and the spermatic veins on both sides were dilated and tortuous. Later, he had several applications of radium to patches of cavernositis. Fourteen months after the operation, he still suffered from frequency, and occasionally had pain previous to micturition. Undoubtedly, there is a large functional element in his case, which the various operative procedures have intensified rather than helped.

Comment.—The salient features of these cases (Cases 9 to 20 inclusive) and the results of surgical treatment are summarized in Tables 2 *a* and 2 *b*. It will be noted that in Table 2 *b* we have not used the word "cured," and this for two reasons: first, we realize that sympathetic neurectomy is merely symptomatic treatment, although, as has been pointed out, it may exercise a local curative effect by improving the nutrition of the affected part, and second, none of our patients has been restored to normality, although in a proportion of cases the relief that followed the operation has been satisfying both from social and economic points of view. Of more interest to us have been the discrepancies between the results of operation in apparently similar cases. While the worth of any new procedure is being tested it is as inevitable as it is tantalizing that an accurate preoperative assessment cannot be made of the amount of relief to be expected in any given case. On the whole we feel that when the lesion is most severe in the basal part of the bladder, the operation may be advised more hopefully, but even to

this broad rule there have been exceptions. We have seen ulceration in the dome of the bladder persist after sympathectomy, whereas the basal lesions healed (Case 18); the resection of the ulcer in the dome was followed by relief which may now be permanent.

TABLE 2 *a*. SYNOPSIS OF CASES OF VESICAL PAIN

Age and sex	Cause of vesical pain	Duration, years	Interval, months*	Comment
1. Resection of presacral nerve				
40M	Interstitial cystitis	5	18	No relief
35F	Interstitial cystitis	2	17	Slight relief
59M	Interstitial cystitis	14	16	Marked relief of pain
38F	Residue of tuberculous cystitis	5	17	Marked relief of pain; some frequency remains
47F	Interstitial cystitis	9	1	Too soon to estimate relief
2. Resection of presacral nerve plus resection of sacral rami communicantes				
29M	Interstitial cystitis	7	14	No relief, relapse after 7 months
52M	Chronic cystitis after prostatectomy	2	12	Marked relief of pain
39F	Interstitial cystitis	1.5	10	No relief
58F	Interstitial cystitis	10	12	No pain in bladder but soreness from urethral caruncle
3. Resection of presacral nerve plus local measures				
29F	Interstitial cystitis	6	18	Plus resection of ulcer on dome; complete relief
57F	Carcinoma of bladder	?	7	Plus deep roentgen ray therapy; relieved until death
32M	Posterior urethritis and trigonitis	18	15	Relief of severe pain; no diminution in frequency

*Since operation.

TABLE 2 *b*. RESULTS OF SURGICAL TREATMENT IN CASES OF VESICAL PAIN

Patients	12
Cases in which resection of presacral nerve was a factor in giving relief	7
Patients relieved by neurectomy alone	5
Patients relieved by all procedures	8

Almost all the patients who have obtained relief state that they are free from the constant vesical pain which was so disabling before operation. It is interesting to speculate on the genesis of this pain; its constant character seems to rule out contraction of the musculature of the bladder as the adequate stimulus, although in other cases in which relief was obtained by sympathectomy the pain has undoubtedly been of the nature of muscular cramp. Although there is no pathologic or anatomic basis for it, we incline to the hypothesis that the relief from constant pain is an expression of improved nutrition, and does not necessarily predicate the division of pain fibers in the sympathetic nerves, whereas the relief from spasmodic pain is probably a direct de-afferentation of the vesical musculature.

On the whole, the results of the operation of sympathetic neurectomy for vesical pain have disappointed us, not so much with regard to the degree of relief afforded, but more from the surgeon's inability to assess the prognosis.

OBSTRUCTION AT OUTLET OF BLADDER

Apart from obvious hypertrophy or inflammatory enlargement of the structures at the outlet of the bladder, there are two conceivable ways in which the outflow of urine might be impeded. The circular muscle around the orifice of the urethra has for its motor nerves the sympathetic nerves to the pelvis, and it is possible that overactivity of these nerves may so increase the tonus of the sphincter that it offers undue resistance to the outflow of fluid. Within the last few years the conception of spasm of a smooth sphincter has lost ground with clinicians and physiologists, and there is a tendency to consider such conditions as being due to achalasia of the sphincter in question. This term introduces the conception that the difficulty at the outlet is due not to the hyperactivity of a perhaps hypertrophied muscle, but rather to the inability of a muscle, even of normal dimensions, to relax in a manner coördinated with the contractions of the bladder; thus the term has been applied to certain cases of obstruction at the lower end of the esophagus, and to certain types of idiopathic dilatation of the colon. The term, and what it implies, have much to recommend them, but not all obstructions due to contraction of smooth muscle fall into this category, and the very fact that many of these

conditions are benefited by sympathetic denervation makes it a little difficult to understand how a muscle deprived of part of its nerve supply could be in any better condition to contract and relax in a coördinated manner.

Case 21.—A man, aged fifty-nine years, for ten years had had increasing difficulty in starting the flow of urine. He had had much urologic treatment, including several punch operations and suprapubic cystostomy. In spite of this, the condition became steadily worse, and for the preceding two years he had been unable to pass urine without taking a rectal injection of hot water. He was a highly intelligent man, and felt that some spasm existed in the neighborhood of the neck of the bladder. After presacral neurectomy, he felt that this spasm had been relieved, and even in bed did not have any difficulty in passing his urine. This satisfactory result has lasted for a year.

Comment.—From a clinical point of view, this case is valuable because we feel that the successful outcome can be attributed directly to the neurectomy. No organic obstruction could be detected at the outlet of the bladder, and indeed this was not to be expected after the urologic operations. An interesting side light on the relief of spasm is the fact that an inguinal hernia, which had been a source of great annoyance during the period of vesical disability, disappeared when he began to micturate normally, and has not returned.

Case 22.—A woman, aged fifty-three years, had been conscious for two years that she was not passing all her urine. This urinary retention had suddenly become complete ten weeks before she came to The Mayo Clinic. On cystoscopic examination, a cause for the retention could not be found, and in particular obstruction at the outlet of the bladder was absent. Sensation appeared to be normal, and after the introduction of a catheter expulsive force was also normal. At first a diagnosis was made of hysterical retention, and in an effort to overcome this, the patient was treated with acetylcholine administered intramuscularly. She did not improve under this treatment, and finally, on the hypothesis that the difficulty might be due to neuromuscular imbalance affecting the region of the internal sphincter, sympathectomy was performed. The operation was not followed by any improvement. Three weeks after operation, at cystoscopic examination, the expulsive force was found to be normal, but there was no definite relaxation of the sphincter; there seemed to be a collar of the trigonal muscle, just within the sphincter, which might have acted as an obstruction. The sphincter and this collar of tissue were divided with a cautery knife, after which the patient was able to void small quantities of urine for

the first time in eight months. A week later, the extent of the division of the sphincter was increased by electrocautery incision of the lower part of the sphincter. After this procedure, the patient could empty the bladder completely, and she has remained well for five months.

Comment.—There is a good deal of obscurity about the etiology of this case. The neurectomy was not followed by the usual amount of dilatation of the internal sphincter, which cannot be ascribed to an incomplete operation, because the procedure was extremely easy. The extent of the local operation required to relieve the obstruction makes it likely that some local hypertrophy was the cause, an hypertrophy which had been gradually increasing for two years, until by a combination of increase in size and gradual overdistention of the bladder, complete retention supervened. On the other hand, it is surprising that the expulsive power of the bladder remained so good in face of the long-continued obstruction. In this case, neurectomy would appear to have been an error of judgment, and urologic measures alone would probably have been successful.

Case 23.—A woman, aged forty-five years, had been perfectly well until three months previously, when she began to suffer from frequency of micturition, accompanied by chills and fever. On cystoscopy elsewhere, she was found to have residual urine, and she was referred to us for consideration of presacral neurectomy. On examination, no evidence was found of neuromuscular disease; expulsive force and sensation were normal. However, 150 c.c. of residual urine was present. A urogram made by the intravenous route showed normal pelves, calices, and ureters on both sides. Sphincterotomy was first performed, but still some residual urine persisted; in an effort to reduce this, the presacral nerve was resected. The immediate result of the combined operation was excellent at first, but in course of time the residual urine returned and she has not received any permanent benefit.

Comment.—This case, like the last, should probably have been reserved for urologic treatment alone. It was our impression that a more radical resection of the internal sphincter muscle would correct the urinary difficulty.

Case 24.—A man, aged forty-nine years, had had difficulty in starting the flow of urine for twenty-five years. On examination, it was found that he had 140 c.c. of residual urine. There was, however, normal expulsive force and normal sensation. A cystogram showed the presence of numerous small diverticula in the bladder, with dilatation of the lower ends of both ureters. On the possibility that the urinary

obstruction might be due to neuromuscular imbalance, presacral neurectomy was first performed, but without benefit. The bladder was then explored by Dr. Waltman Walters, with a view to dealing with the largest diverticula, but it was found that these received the ureters on both sides, and it was judged inadvisable to perform any plastic operation. At a later date, the sphincter muscle was cut, and this was followed by considerable temporary relief. However, a report twelve months afterward stated that the man was still having much trouble.

Comment.—In this case also the ultimate cause of the difficulty is obscure. We would have liked to postulate injury to the nerves of the bladder as a result of pressure of the diverticula which adjoined them, but unfortunately for this view the obstruction must have been present before the diverticula. It is possible that a more complete division of the internal sphincter would be efficacious.

PHYSIOLOGIC AND ANATOMIC RESULTS OF NEURECTOMY OF THE PRESACRAL NERVE

The anatomic architecture of the bladder and of the openings into it is modified after resection of the presacral nerve. Changes have not been observed in the dome and lateral walls, but relaxation of the trigone is a constant finding in the bladder of men. This relaxation of the trigone is neither so constant nor so marked in the bladder of women, and, in one or two cases, it has been replaced by a falling away of the base of the bladder on each side of the trigonal area. It is not surprising that there should be differences between the sexes, for these have been frequently observed in other vertebrates.

The ureteral orifices remain somewhat relaxed. Probably this is the result of paralysis of the trigonal sheet of muscle which, as has been pointed out by Zuckerkandl and others, is so disposed that its contraction closes off the intramural part of the ureter. We believe it to be significant that dilatation of the ureter does not follow the operation of presacral neurectomy, as a consequence of this muscular relaxation. This would appear to provide adequate proof that the mere mechanical arrangement of the lower end of the ureter is sufficient to prevent urinary reflux during contractions of the bladder. There has not been any clinical or radiologic evidence of back pressure in any of our cases save two, in which the condition was present before operation. As observed with the

cystoscope, the operation is not followed by any disturbance of the ordered delivery of urine into the bladder.

For the first week or two after operation, the internal sphincter is dilated and rather toneless, but subsequently the muscle becomes tonic again; at least in the male this recovery of tonus has never

TABLE 3 *a*. SYNOPSIS OF CASES OF OBSTRUCTION AT OUTLET OF BLADDER

Age and sex	Cause of vesical paralysis	Duration, years	Interval, months*	Comment
1. Resection of presacral nerve				
59M	Neuromuscular imbalance (achalasia)	10	11	Completely relieved
2. Resection of presacral nerve plus sphincterotomy				
53F	Unknown	2	5	Not relieved by neurectomy; completely relieved by sphincterotomy
45F	Following "cystitis"	3	5	No relief from either procedure
3. Resection of presacral nerve plus suprapubic cystostomy plus sphincterotomy				
49M	Unknown	25	12	Temporarily relieved; difficulty still present

*Time between last operation and last examination or report.

TABLE 3 *b*. RESULTS OF SURGICAL TREATMENT IN CASES OF OBSTRUCTION AT OUTLET OF BLADDER

Patients	4
Cases in which resection of presacral nerve was a factor in relieving obstruction	1
Patients cured by resection of presacral nerve alone	1
Patients cured by all procedures	2

proceeded to complete closure. In the female, the relaxation of the internal sphincter has never led to incontinence, and we must therefore postulate a sphincteric function of the musculature around the female urethra, although its anatomic arrangement seems entirely unsuited for this, and most observers consider the internal sphincter to play the major if not the sole part in urinary control.

A return of tonus comparable to that seen in the internal sphincter has never been observed in the trigone, and thus it happens that when relaxation of the trigone is marked, the posterior segment of the internal sphincter forms a ridge which dams back urine in the base of the bladder. To rectify this difficulty, we have found it efficacious to divide this sphincteric ridge, so that the trigonal pool communicates directly with the urethra. More than once this subsidiary operation has enabled a patient to pass the last remnant of residual urine. As will be noted in Table 3 *a*, it has also cured patients who have remained unbenefited by resection of the presacral nerve.

One feature which has been constantly observed with the cystoscope is an increase in the expulsive power of the bladder. We have already remarked that this may be due either to the removal of a constantly acting brake on vesical contractions, or to reduction in the power of the bladder to accommodate its size to increasing amounts of fluid.

It may be added that conception, normal pregnancy, and normal parturition have followed the operation on women. Male patients, however, must be warned that although not impotent they will be sterile.

CONCLUSIONS

We have scarcely enough material to enable us to assess the final value of sympathetic neurectomy in these vesical conditions. We would, however, draw attention to what seems to us to be a significant fact. A case, or cases, will be found in each of the three groups in which section of the presacral nerve alone was effective, either as a primary operation or after local procedures had failed. We are of the opinion, therefore, that the operation has a place in the urologic armamentarium, and that in suitable cases, the possibility of its application should be considered. As time passes, no doubt the indications for the operation will be more strictly defined, and this may mean either restriction of its field, or expansion to include other conditions. We are satisfied of its occasional value in our own practice.

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DISCUSSION

Dr. George G. Smith (Boston): In the Palmer Memorial Hospital in Boston, a good many operations are done for radical removal of carcinoma of the rectum. It happens, almost as a rule, after these operations, that the patients have urinary retention which may last for a long time, and we urologists are called in and asked to advise about these patients and to suggest treatment.

In the operation the rectum with the perirectal fatty tissue is cleaned out of the pelvis. It seems probable that some of the vesical nerves coming from the sacrum are interfered with.

I wish Dr. Learmonth would comment on this situation and say whether he thinks that section of the presacral nerve at the time of operation would be likely to prevent the occurrence of vesical paralysis.

Dr. K. H. Watkins (Manchester, England): May I trespass on your hospitality to make one small observation in connection with the problem of paralysis of the bladder? Dr. Learmonth has explained to us how the operation of presacral neurectomy improves the expulsive force of the bladder.

It appears that there are two types of paralysis of the bladder. In the one familiar to all of us, in the bladder of the tabetic patient, there is a marked flaccid condition of the detrusor muscle. In the other, which is perhaps less familiar to us, we find a very markedly hypertrophic bladder. In this condition the detrusor muscle presents a most peculiar resistance to distention of the bladder, to which fact Plaggemeyer called attention in 1919. It is easy, by doing cystometric examination, to show that in such a bladder, when a small quantity of fluid is introduced the intravesical pressure rises very considerably.

It is also apparent that such bladders exhibit a failure to contract down to the limit, because catheteric evacuation of such a bladder is always incomplete unless assisted by abdominal straining or suprapubic pressure.

This bladder then shows a detrusor muscle with a most extraordinary rigidity, which has marked reluctance to alteration in the length of its muscle fibers.

In 1905 Elliot drew attention to the fact that after pelvic nerve section in animals, the detrusor muscle showed a remarkable hypertrophy. He also suggested that this condition was due to a hyperactivity of the sympathetic system, a fact for which he had experimental basis.

I think these facts have a very definite bearing on Dr. Learmonth's work, and I do feel that a differentiation of these two types of detrusor muscle will in the future be a help in selecting cases for presacral neurectomy.

DR. WILLIAM F. BRAASCH (Rochester, Minn.): I have played a very humble part in this work of Dr. Learmonth's. My main assistance was from a cystoscopic viewpoint in noting the various changes in the appearance of the bladder and its function before and after operation, as well as the indications for the operation.

I was particularly struck with the difference in the physiologic results after presacral resection. There was a wide variation in these results, which were sometimes quite baffling. Dr. Learmonth has already referred to some of them.

Needless to say, in every case of interstitial cystitis in which a resection of the presacral nerve was made, every form of palliative treatment was tried first. We have established a routine method of treatment, including lavage, over-distention, fulguration, and so forth. In several cases with a localized area of ulceration and perivesical infiltration, resection was attempted and followed by relief in some. Resection of the presacral nerve was used only as a last resort. Certainly it should not be the first step in the way of treatment of this or any painful condition of the bladder.

Very frequently the results are slow to show, and may be delayed some time after the patient has been dismissed from the clinic. In most cases the relief is immediate.

I would say that Dr. Learmonth was very conservative in his estimate of 50 per cent improvement in this operation. In my opinion, fully two-thirds of the patients have shown varying degrees of improvement. The operation is certainly well worth while.

DR. C. M. MCKENNA (Chicago): Dr. Learmonth mentioned interstitial cystitis as an indication for this particular operation. I should like to add that we have seen two such cases in our clinic and both have been diagnosed as interstitial cystitis or pericystitis.

In the first case, a woman, sixty years of age, came in with all the symptoms of a patient suffering with a contraction of the bladder. Her bladder capacity when she entered the clinic was 87 c.c. of fluid. This was measured carefully with a hand syringe. A cystoscopic examination was made with this amount of fluid in the bladder, and the diagnosis of an interstitial cystitis was confirmed. The patient was then sent to the hospital and a caudal anesthesia was given and the bladder dilated by the gravity method until the bladder retained 400 c.c. of fluid. We noticed on emptying the bladder before cystoscopy, the water was colored with streaks of blood. On cystoscopic examination it was very evident that the patient had two definite linear ulcers well up towards the fundus of the bladder, that could not be seen before the bladder was dilated. The ulcers were fulgurated, and the patient seemed to get immediate relief.

I should like to add that this patient also was diabetic. She was put on diabetic management, and up to the present time she seems to be very comfortable. It would be interesting to know whether or not the sugar in the urine had anything to do with the ulcers. It certainly would be irritating to say the least.

In conclusion, I think this method should be carried out before any radical operation is attempted.

Dr. Hermon C. Bumpus (Rochester, Minn.): I was interested in Dr. Fowler's paper because recently Dr. Cabot remarked to me that anyone who did any considerable series of litholapaxies would sometimes be sure to be chagrined by finding that only half of the stone which one was attempting to crush was in the bladder and the other half in a diverticulum.

I think we have to add to that the chagrin of trying to crush a stone formed around a suture. My associate, Dr. Crenshaw, reported such a case. The patient had a herniotomy done a year or so before. The stone which he presumed was loose in the bladder was attached to a suture, and in crushing it, the bladder was torn and death from peritonitis ensued.

It would seem that one must hold under suspicion any bladder stones found following operations in the neighborhood of the bladder.

Dr. F. R. Hagner (Washington, D. C.): I would like to speak

of a case that Dr. Kerr had in Washington of a foreign body in the abdomen which came near being migrating. The patient was a woman upon whom he operated for appendicitis. This patient had an appendicitis operation done and there were vesical symptoms and still a little sinus where the appendiceal operation had been done.

I made a cystoscopic examination and at once told the doctor I thought there was a foreign body on the other side of the bladder and asked whether the appendix was near the bladder. He said, "Not at all. It was over on the side." There was a red mass in the bladder about that size (indicating), projecting down. The more I looked at it the more I thought it was a tumor. Finally I made this suggestion, "It may be a tumor. I think you had better look in the wound and see if there is anything." There was a sponge in the wound, pressing on the bladder, that gave almost a typical appearance of tumor.

Dr. John R. Caulk (St. Louis): I have seen several cases of encrusted sutures on the dome of the bladder, and in one instance I had quite a lot of difficulty in removing the suture, practically pulling the bladder wall with it. Finally in one case we left the distal end of the suture in the wall, just broke it off and left it there, and I have never heard from it since. In one instance it came out very easily.

Seven years ago, a woman who had had a previous hysterectomy about six or seven years before, came in with symptoms of vesical calculus. We found a large stone in her bladder and through X-ray found a very interesting thing. A large surgeon's needle was the nucleus of the stone. Evidently the needle had been left in the abdominal cavity and migrated into the bladder in the meantime. The stone was crushed and the needle removed with a Young's rongeur cystoscope.

Dr. D. W. MacKenzie (Montreal, Canada): In discussing Dr. Fowler's paper, I wish to refer to a patient, a young married woman who, six months previous to coming to us, had perineorrhaphy and plastic surgery for cystocele by a very good man in another town. On routine examination, she was found to have a vesical calculus. Cystotomy proved it to be an encrusted gauze sponge. How did it get to the bladder? Certainly it didn't seem possible

that it could have gone through the urethra; it was too large anyway. It was not a likely thing for a very good surgeon to do. The only explanation we could make was that in controlling hemorrhage well up in the fornix, a sponge was left and it had possibly eroded through to the bladder cavity.

DR. RICHARD F. O'NEIL (Boston): In regard to Dr. Jeck's communication on air embolism, I would like to mention a case we had some years ago of air embolism of the urethra which, while not fatal, was near enough to give us great concern.

Dr. Chute brought over an air-distending urethroscope from England. We had a man at the Boston Dispensary Clinic who had a tight stricture. We could not get any instrument through and thought possibly, by putting in the endoscope and dilating the urethra we might be able to see the orifice of the stricture. We put in the instrument and injected some air. Almost immediately the man said he felt a little queer. To make sure, we gave him another shot of air, and he promptly went into an extremely alarming condition. He became cyanosed and his pulse was very poor. He stayed in this condition for three or four hours, but finally came out of it.

I do not know whether or not Dr. Chute still has that urethroscope, but if so, I will bet he has not used it.

DR. H. L. KRETSCHMER (Chicago): I was very much interested in listening to Dr. MacKenzie's report. In his case, as I understood him, a simple perineorrhaphy had been done and a sponge had migrated into the bladder.

I wish to refer briefly to a somewhat similar experience of my own. A patient had been operated upon elsewhere. She had a perineorrhaphy and at that time a cystocele had been repaired. I saw her one year after her operation, with symptoms that suggested the possibility of a tumor. I made a diagnosis of a foreign body in the bladder and removed the sponge through a suprapubic cystostomy.

In reference to Dr. Fowler's case, I should like to mention a patient who had some pelvic work done by a very competent gynecologist. Following her gynecologic work, the patient had great urinary distress that persisted for a year, and she was finally sent in for a cystoscopic examination. The cystoscopic examination showed the presence of a black silk suture on the dome of the blad-

der. There was no incrustation and the suture was removed with a cystoscopic rongeur. I discussed this case with the gynecologist, and he said that he had used black silk in some of his work.

DR. HOWARD S. JECK (New York City): Shortly after this accident happened I was discussing it casually with several urologists and one of them asked why we distended the bladder at all. He said he did not do it—that he was in the habit of opening bladders under spinal anesthesia. I told him we performed nearly all our cystotomies, especially those preparatory to prostatectomy, under local anesthesia and that distention of the bladder made the operation easier.

If one uses spinal anesthesia it is, of course, easy enough to open the bladder without distending it.

After I had finished reading my paper and had returned to my seat, Dr. Redewill of San Francisco, who is one of our guests, passed over to me the following communication which is very interesting and apropos. I asked him to present it but he said he preferred to have me do it.

"At the Hooper Foundation for Medical Research of the University of California, we found it is the nitrogen of the air that produces the embolism. On the other hand, if carbon dioxide or oxygen is injected even into distal veins, these gases are absorbed as fast as they are injected. They are therefore all absorbed before that particular blood reaches the heart, so that no cardiac gas embolism occurs. Of the two gases, carbon dioxide and oxygen, oxygen is absorbed twice as fast as carbon dioxide, and is the ideal gas to use in injecting any cavity of the body when there is danger of gas entering the venous plexuses."

DR. J. R. LEARMONTH (Rochester, Minn.): The question of difficulty in passing water after resection of the rectum has been brought to my attention by the surgeons of the clinic. I have never felt justified in advising resection of the presacral nerve as a secondary operation, in these cases, because the question of permanent cure is perhaps doubtful.

I think it would be a good plan, from two points of view, if surgeons would divide the presacral nerve when they explore and make the colostomy: first, because it might help to deal with any urinary difficulty; second, it would interrupt pain impulses from the rectum, and if there is a visceral recurrence of cancer or if there is a glandular metastasis which involves a viscus, the neurectomy would make the patient's life easier.

With regard to the operation for interstitial cystitis, I hope I did not give the impression that I was allowed to do it as a primary operation. I think you probably know Dr. Braasch better than that. It is done only after prolonged urologic treatment has failed to improve the condition.

A STUDY OF THE VESICAL END OF THE URETER IN HYDRONEPHROSIS*

A REPORT OF FIFTEEN CASES

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When infants and children are examined and pyelograms are made, either intravenously or from below, showing dilatation of the kidney pelvis and ureter, a diagnosis of stricture of the ureter with hydronephrosis and hydro-ureter is in order.

By reason of the general interest in the subject of stricture of the ureter in adults, and the frequency of hydro-ureter and hydronephrosis in children, we became interested in the subject and this led to a desire to determine whether in these cases the obstruction at the lower end of the ureter was due to stricture in the generally accepted meaning of that word.

According to Braasch and Frater[1] "a stricture is a narrowing, beyond the normal anatomic and physiologic limits, of a hollow muscular tube. Microscopically a stricture may show: (a) changes in the epithelium, such as destructions; (b) narrowing of the lumen up to complete obliteration; (c) evidence of inflammatory reaction, such as leukocytic collections in the wall of the ureter; (d) increase in fibrous tissue normally present; and (e) hyalinization of muscle."

The histologic study in our cases, instead of showing the foregoing requirements for stricture, showed that the obstruction which produced the hydro-ureter and hydronephrosis was due to hypertrophy of the muscular longitudinal fibers, with few exceptions, of anomalous insertions of the ureters. Inflammatory changes were of recent origin only, and were not the cause of the essential primary narrowing of the lower ends of the ureters.

This paper is based on a series of fifteen post-mortem specimens from the Children's Memorial Hospital of Chicago.

Case 1†—R. C., male, aged one month, was admitted to the Children's Memorial Hospital, September 12, 1927, on account of projectile vomiting. There were no urinary symptoms.

*From The Children's Memorial Hospital and from the A. D. Thompson Urological Fund of Rush Medical College of the University of Chicago.

†Previously reported. Kretschmer and Pierson: Congenital Valves of The Posterior Urethra. Amer. Jour. of Diseases in Children, October, 1928, 38:804.

The physical examination was negative except for a slight injection of the throat and a questionable walnut-sized mass in the right upper quadrant. Peristaltic waves were visible.

The urinalysis was negative.

A tentative diagnosis was made of pyloric obstruction and operation advised.

On September 12, 1927, an exploratory laparotomy was performed. No pyloric tumor was found. Temperature varied from 100 to 102 degrees following the operation.

The child died on the second day following the operation.

Clinical diagnosis was bronchopneumonia.

Following autopsy, September 15, 1927, anatomic diagnosis was congenital valve in the posterior urethra; hypertrophy and dilatation of the urinary bladder; hydro-ureter and hydronephrosis, bilateral, with infection (streptococcus); bronchopneumonia.

Specimen of the kidneys showed a moderate amount of hydronephrosis. The renal pelves were dilated. The ureters were dilated from the renal pelves down to the bladder wall. The degree of dilatation was as marked at the bladder as at the upper end. The wall of the bladder was enormously dilated, but there were no evidences of trabeculation. The ureteral orifices appeared normal.

The intramural part of the ureter appeared thick and rigid. Further examination showed that the dilatation began at the juxtavesical part of the ureter. The ureters were enormously dilated and tortuous, and the walls were thin. When the dissection of the ureters was carried through the wall of the bladder, it was noted that the intramural parts of the ureters were thickened but not dilated.

Histology.—In serial sections of the juxtavesical portion of each ureter the lumen was contracted and had thick epithelium of wide cells, and a rather narrow mucous membrane. At least three-fourths of the ureter wall consisted of muscle fibers, most of which were longitudinal, and only a few of them were circular fibers. The muscle was in small bundles, separated by delicate fibrous reticula.

The serial sections of both ureters were essentially identical. Muscle hypertrophy was marked and in the lower ureter distal to the juxtavesical portion the circular and longitudinal fibers were about equal in amount.

In the mid-portion of the ureters their walls were thin, the lining epithelium was narrow, the mucous membrane practically obliterated, and the structure was largely muscular, circular and longitudinal fibers being equally distributed. The peripheral connective tissue was scant.

There was extensive hyalinization of the bladder musculature. The bladder wall was only slightly thicker than the wall of the ureter.

Case 2.—C. M., male, aged one year, was admitted March 18, 1931. The infant had a spina bifida and a painless swelling of the left thigh and left leg of one week's duration. When born there was a swelling

on the back about the size of half an egg, and this discharged for two or three months.

There was marked incontinence of urine.

The patient was a pale, fat, and apparently ill infant. There was marked swelling of the left lower extremity from the hip to and including the foot; marked bilateral calcaneo-equinovalgus. Knee jerks were absent.

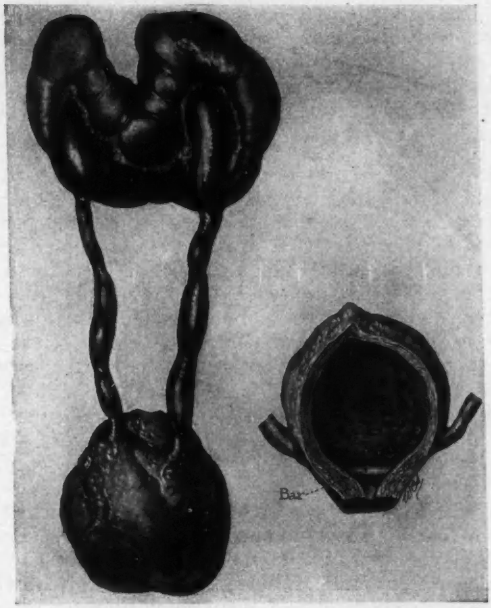

Fig. 1. Case 2. Horseshoe kidney with bilateral dilatation of kidney pelves and ureters. The dilatation terminates about 5 centimeters above the bladder. Bladder wall thickened. Note presence of bar.

Roentgen-ray examination showed a fracture of the left femur.

The child ran a septic temperature which rose to 105 degrees daily. Examination of the urine showed albumin and a small amount of pus. Subsequently he developed bilateral otitis media and bronchopneumonia, and died on April 15, 1931.

Clinical diagnosis was spina bifida; talipes equinovalgus; fracture of the femur; bronchopneumonia; otitis media; secondary anemia.

Following autopsy, April 16, 1931, anatomic diagnosis was horseshoe-shape kidney; hydro-ureters and hydronephrosis; extensive

bilateral bronchopneumonia; spina bifida; talipes equinovalgus; fracture of the femur; generalized anemia; acute otitis media.

Specimen of the kidneys showed them to be completely fused at the lower poles. Each had a separate blood supply and each half had a separate pelvis (Fig. 1). Both renal pelves were equally dilated.

The ureters were dilated, the left more so than the right. The dilatation extended from the ureteropelvic junction down to a point about 5 mm. above the bladder on the right side and about 4 mm. above the bladder on the left side, at which point the ureter was of normal circumference and thickened. Below this point the ureter approached the normal and the intramural part was normal.

The bladder wall was thickened and showed some trabeculations with superficial cellules, and the presence of a median bar. The ureteral openings were normal.

Histology.—In serial sections of the lower end of each ureter, the walls were thick, the lumen contracted and lined with stratified epithelium in folds. There is practically no subepithelial mucous membrane. The thickness of this contracted portion was composed essentially of muscle fibers, the longitudinal fibers predominating. These fibers were encased in connective tissue extending to the periphery.

Directly above the juxtavesical portions the lumen was larger, its diameter being at least twice as great as below. Here the muscle hypertrophy was marked, but the fibers were farther apart and the connective tissue less dense.

Similar serial sections of a portion of the midureter and upper ureter were thin. This thinness was in all the layers. The mucous membrane was almost absent.

Case 3.—T. S., male, aged twelve months, was admitted September 2, 1925. The following symptoms were present: intense restlessness, fever, diarrhea, vomiting, and loss of weight—began one week prior to admission to the hospital. Urinary symptoms were absent.

The child was a well developed, dehydrated infant. Physical examination was negative. Temperature on admission was 102.6 degrees. Examination of the urine showed a large amount of pus and albumin, and B. coli on culture.

Death occurred sixteen hours after admission to the hospital.

Clinical diagnosis was alimentary intoxication.

Following autopsy, September 3, 1925, anatomic diagnosis was emaciation and generalized anemia; diverticulum of bladder, hydroureter and hydronephrosis, left; ectopic right kidney.

Specimen showed fetal lobulations in the right kidney; otherwise normal (Fig. 2). The right ureter measured 85 mm. in length. There was a slight evidence of dilatation in the left kidney. The left ureter from its orifice to the ureteropelvic junction measured 175 mm. It was not tortuous, the walls were thickened and dilated. The point

of maximum dilatation, 35 mm. in circumference, was about 30 mm. above the ureteral orifice. Below this point of maximum dilatation the ureter was 4 mm. in diameter; its intramural part was apparently normal.

The bladder wall showed well-defined hypertrophy and the presence of a small diverticulum at the site of insertion of the left ureter into the bladder.

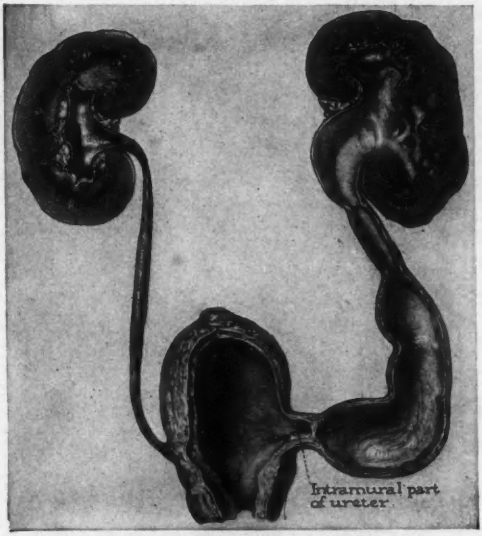

Fig. 2. Case 3. The left ureteral orifice is normal; intramural part of the ureter not dilated. Dilatation of ureter begins above the bladder. Note presence of superficial diverticulum.

The autopsy records of this case failed to state whether or not obstruction was present at or in front of the neck of the bladder.

Histology.—The serial sections of the lower portion of the left ureter contained a part of a bladder diverticulum behind which was the narrow ureter. The epithelium here was narrow, and generally only two cells high. The mucous membrane varied in amount but was generally thick and extended centrally into the folds of the epithelium, being well-defined peripherally where it joined the muscularis. Here the muscle bundles, each bundle consisting of compressed fibers, were clumped together. These bundles were generally three to five times the usual size, and about two-thirds of them consisted of longitudinal fibers. In cross sections, portions of the wall were without muscle

fibers between the lumen and periphery, and it was in the periphery that the fibers were clumped.

In serial sections higher up in the ureter the wall was thin, the epithelium narrow, the mucous membrane absent, and the essential content of the wall was the muscularis.

Throughout all sections of the ureter there was a rather extensive infiltration of lymphocytes into the lining mucous membrane.

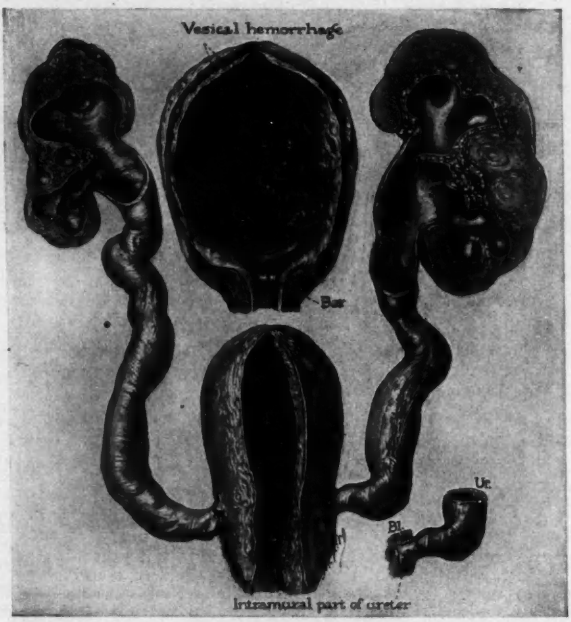

Fig. 3. Case 4. Enormous dilatation of the kidney pelves and ureters down to the bladder wall. Intramural part of the ureter not dilated. (*Insert*) Thickening of trigone and bladder wall. Presence of median bar.

Case 4.—D. W., male, aged four years, was admitted March 8, 1919, on account of fever, cough, loss of appetite and constipation.

There was incontinence of urine on admission so the child was wet all the time. Temperature was 102.4 degrees.

The child appeared to be acutely ill. There was a slight discharge from the nose. The tonsils were large and covered with a yellow mucous material. The lungs revealed many mucous râles, posteriorly from the third to the ninth ribs on both sides. In the abdomen was

a suprapubic tumor which disappeared after catheterization, but on the following day the tumor reappeared. After each catheterization the tumor disappeared.

Examination of the blood showed white cells 17,000; red cells 5,150,000; hemoglobin 70 per cent.

Examination of the urine showed pus and B. coli on culture.

Death occurred on March 31, 1919.

Clinical diagnosis was acute pyelocystitis; retention of urine.

Following autopsy March 31, 1919, anatomic diagnosis was multiple abscesses of the kidneys; bilateral hydronephrosis with infection; dilatation of ureters; median bar; chronic cystitis; hypertrophy of bladder wall; congenital valve in posterior urethra.

Specimen showed the left kidney (Fig. 3) to be three times the size of the right; the surface was studded with many miliary abscesses. A moderate amount of hydronephrosis was noted. The right kidney was almost completely destroyed by hydronephrosis. Only a small amount of renal tissue remained at the upper pole.

The ureters were dilated, very tortuous, and the walls were decidedly thickened. The dilatation extended from the ureteropelvic junction down to the bladder. The intramural part of the ureter was thickened but not dilated. There was no evidence of narrowing of the lumen. The dilatation began above the intramural part of the ureter.

The bladder wall was thick, the mucosa rough and markedly hyperemic, in places mottled with recent hemorrhages; most marked on the back portion. The interureteric ligament was thickened. The ureteral openings were normal. A median bar and a congenital valve in the posterior urethra were present.

Histology.—Serial sections from fourteen blocks of different portions of the ureters were studied. The lining mucous membrane was swollen in all of them and was the site of subacute and chronic inflammation with a purulent exudate into the lumen. From the intramural portions distally to the kidneys the changes of both ureters were identical.

In the intramural, and especially in the juxtavesical, portions of the ureters the muscle fibers were so greatly enlarged that in places the thickened wall had muscle fibers for four-fifths of its thickness. The longitudinal fibers were slightly more abundant than the circular ones, many of which had undergone hyalin degeneration. Everywhere the mucous membrane was narrow.

As the ureters were followed to the kidney the wall became less thick, the predominance of circular and longitudinal fibers varied and was of normal amount.

Case 5.—D. S., female, aged thirty-two days, was first admitted November 5, 1928. The significant findings at that time were otitis

media and a prolapsed rectum together with exstrophy of the bladder. Examination of the urine showed a few pus cells only.

On March 19, 1929, the child was re-admitted because of a prolapsed rectum and an acute attack of pyelitis.

The infant subsequently developed bronchopneumonia and died on March 26, 1929.

Clinical diagnosis was exstrophy of the bladder; acute pyelonephritis; prolapse of the rectum; otitis media; bronchopneumonia; empyema, right.

Following autopsy March 26, 1929, anatomic diagnosis was exstrophy of the bladder; subacute cystitis and ureteritis; diffuse bronchopneumonia; empyema; ventral hernia.

The urinary bladder was present in the front abdominal wall in the midline just above the symphysis pubis for a place 4.5 cm. in diameter. It was sharply defined from the adjacent, pale white skin, because of its dark red, edematous lining which was curled up in folds. Two ureteral openings were present, and normal within the wall of the bladder.

On the right side just above the bladder, the ureter was thin-walled and dilated so that it was about twice the size of the left ureter, which was normal throughout its course. The dilatation of the right ureter was present for 5 cm. above the bladder, and above this place it was normal. Below the place of dilatation of the right ureter, which was the juxtavesical portion, this ureter was a contracted, rigid tube continuous through the bladder wall.

The pelvis of each kidney, and the kidneys, were normal.

Histology.—Serial sections of the lower ends of the ureters from the abdominally exposed portions and upwards for 3.8 cm. were studied, also serial sections of each ureter in its midportion.

In the lower portion the wall consisted almost entirely of epithelium of four to six cells thick, and loose mucous membrane in which small bundles of muscle fibers were enmeshed. These were predominantly longitudinal fibers. Circular fibers were sparse. Chronic inflammation was extensive in all portions, although most marked in the lining.

Distally from the abdominal wall the findings were similar, except that the epithelium was less thick. In isolated places, the muscle fibers, however, became prominent only to diminish quickly as the ureter was ascended.

In the midportions of both ureters the walls were normally thin, the epithelium was narrow, the mucous membrane almost absent, and the thickness was largely that of the muscularis. The longitudinal fibers became less prominent so that near the kidneys the circular fibers predominated.

Case 6.—F. L., female, aged eight years, was admitted February 5, 1929, because of inability to walk, a sore throat and marked irritabil-

ity. The present complaints began a week ago with sore throat and fever. Three days before admission to the hospital the patient had a spell of vomiting, and two days later she was unable to walk. Recently she had been having some difficulty in swallowing.

The patient was a well-developed and well-nourished female. The pharynx was moderately inflamed; no membrane and no paralysis. Heart, lungs and abdomen were negative. Reflexes were as follows: Knee-jerks, faint; Kernig's sign, negative; abdominal, present; Babinski, not elicited.

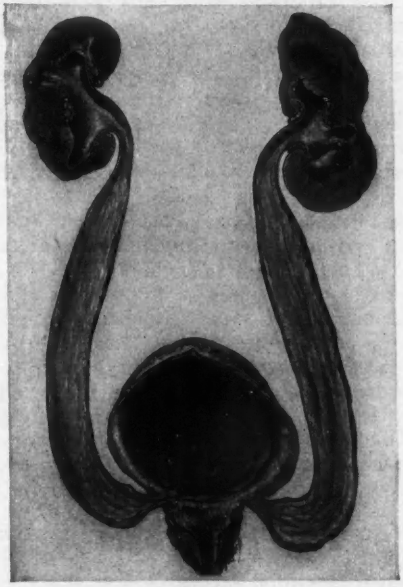

Fig. 4. Case 6. The ureters were uniformly thickened and dilated nearly to the bladder wall.

Examination of the blood showed red cells 4,500,000; white cells 18,600; hemoglobin 80 per cent. Blood chemistry was non-protein nitrogen 165; urea nitrogen 145; and uric acid 9. Blood pressure was systolic 90 and diastolic 80. Von Pirquet and Schick tests were negative.

Examination of the urine showed albumin, pus and a few casts.

The patient developed a bronchopneumonia and died March 3, 1929.

Clinical diagnosis was post-diphtheritic paralysis.

Following autopsy March 3, 1929, anatomic diagnosis was chronic

diffuse nephritis; bilateral hydroureters; chronic hyperplastic ureteritis; bronchopneumonia; caseous and calcified tuberculosis of lungs; parabronchial and mesenteric lymph glands.

Specimen showed a moderate amount of hydronephrosis, more marked on the right side. The right ureteropelvic junction was slightly narrower than the left. Both ureters showed enormous dilatation. The walls were greatly thickened, the ureters were not tortuous, but resembled thick rigid tubes. The dilatation extended almost to the bladder wall (Fig. 4).

Histology.—Serial sections of the ureters were studied in ten different places and included all of the lower ureter. The sections of each ureter were essentially similar.

In the intramural portion the epithelium and entire mucous membrane were swollen and of loose cellular structure. Two separate lymph nodes were present within the mucous membrane of the right ureter in its lower portion. In the bladder wall, the muscle layer of the ureter was retained as small bundles enmeshed in loose connective tissue.

Just above the intramural portions, the lining epithelium and the mucous membrane were similarly swollen, but the ureter thickness was greatly increased. This increase in size applied to the muscle bundles, about three-fourths of each bundle being made up of longitudinal and one-fourth of circular fibers. The hypertrophy of muscle fibers was most marked in the peripheral portions of the sections.

As the ureter was followed upward the muscle hypertrophy persisted, but the predominance between longitudinal and circular fibers varied at different levels. All the muscle fibers stained well.

The lining of the ureter throughout its entire course was diffusely infiltrated by leukocytes in which the lymphocytes predominated. The inflammation was essentially of the mucous membrane.

Case 7.—H. P., male, aged seven months, was admitted February 11, 1921, with complaint of emaciation. The infant was a twin, full term, in a weakened condition at birth. The other infant had done very well, but this one failed to gain and emaciation had progressed since birth.

The patient was an extremely emaciated child showing marked weakness. The skin was wrinkled and pasty gray. The head, neck, and heart were negative. There were distinctive signs of a disseminated bronchopneumonia. Emaciation of the extremities was marked.

Examination of the urine showed albumin and leukocytes.

Death occurred February 15, 1921, four days after admission.

Clinical diagnosis was bronchopneumonia; atrophy, extreme.

Following autopsy, February 16, 1921, anatomic diagnosis was bilateral bronchopneumonia; congenital stenosis of the left ureter; left hydro-ureter and hydronephrosis; ectopic right kidney.

The right kidney was normal. The right ureter measured 78 mm. from the bladder to the ureteropelvic junction. There was a fusiform dilatation 16 mm. long and 6 mm. wide in the lower one-half of the ureter. The ureteropelvic junction was normal. The ureteral orifices and the internal urethral orifice were normal. The ureter just above the bladder showed decided thickening.

The left kidney contained fetal lobulations, and when opened re-

Fig. 5. Case 7. Note thickening of intramural and juxtavesical part of the ureter with dilatation above for about 45 millimeters. Thickening of wall of ureter above this part.

vealed dilatation of the pelvis and a moderate hydronephrosis. The ureter measured 100 mm. in length, and presented an unusual picture: At the ureterovesical junction it appeared thickened for a distance of 7 mm. The next 45 mm. were enormously dilated and the wall unusually thin (Fig. 5). Above this point of great dilatation the ureteral wall was enormously thickened, and midway between the previously described dilatation could be seen two transverse ridges. The pelvis was thin.

There was no evidence of bladder neck obstruction.

Histology.—Serial sections of the ureter were studied in eight grossly different places. These included the entire lower ureter on each side.

In the intramural and juxtavesical portions of the ureters the lumen was contracted, its lining compressed into folds with an epithelial lining three to five cells thick. Here, the mucous membrane reticulum was abundant, but in the peripheral portions the longitudinal muscle fibers were at least twice the usual amount. The circular muscle fibers were normal. The fibers stained well. Except for one focal place where fibrous tissue was clumped inside the ureter wall, the mucous membrane was composed of loose connective tissue.

Directly above the contracted juxtavesical portion the ureter ballooned out, especially on the left side, and the wall was thin. The lining epithelium was narrow, the mucous membrane connective tissue almost absent, and the prominent muscle fibers were almost entirely circular. Above the dilated portion of the ureter the wall was again thick. The thickness consisted of high epithelium, mucous membrane, and muscle fibers, circular and longitudinal in almost equal proportion.

Case 8.—D. F., female, aged six weeks, was admitted August 18, 1927, because of vomiting of one week's duration and diarrhea for ten days. Vomiting, not projectile in character, occurred directly after feeding. There were four to five loose watery stools daily.

There were no urinary symptoms.

The patient was a very small, dehydrated baby. Physical examination was negative except for a moderate injection of the pharynx and a palpable liver.

Examination of the blood showed red cells 3,600,000; white cells 15,400; hemoglobin 62 per cent.

A specimen of urine made post-mortem showed many pus cells.

Death occurred on August 20, 1927, twenty hours after admission.

Clinical diagnosis was gastro-enteritis.

Following autopsy, August 20, 1927, anatomic diagnosis was bilateral duplication of the kidney pelves and ureters; pyo-ureter and pyonephrosis of upper half of the double right kidney; ectopic ureter (right upper) opening into the vagina.

Specimen (Fig. 6) showed that on the left side the kidney was very much smaller than on the right and there was no evidence of hydronephrosis. There were two separate openings into the bladder.

The right kidney showed two pelves and two ureters. The ureter from the lower half and the ureteral orifice were normal. The ureter that drained the upper half of the double kidney was markedly dilated, thin-walled, and tortuous, and it ran under the bladder and urethra, terminating in the vagina. At the point of entrance of the ureter into the vagina there was a definite ring constriction. The opening of this aberrant or ectopic ureter was only 2 mm. in circumference, at which

point the ureter was dilated and measured 24 mm. in circumference. There was no evidence of obstruction in the bladder or urethra. The pelvis was exceedingly thin, as was the rest of the ureter, and there was a marked hydronephrosis with compression-atrophy of the corresponding half of the kidney. There remained only a very thin shell of kidney tissue.

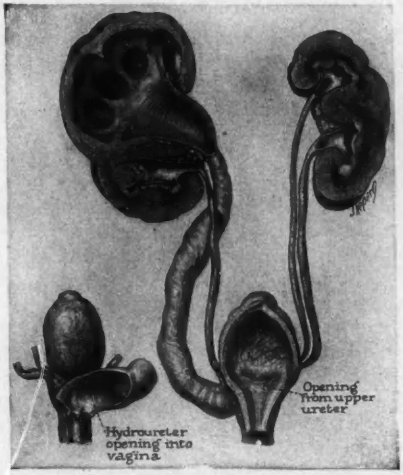

Fig. 6. Case 8. Note enormous dilatation of the ureter draining the upper half of the right double kidney. *(Insert).* Insertion of ureter into the vagina.

Histology.—Of the ureter which came from the upper one-half of the right kidney, serial sections were made of the entire lower portion upward from its opening into the vagina. Serial sections were also made of the midportion of the ureter.

At the vagina, the lining of the ureter was in folds of thickly cellular epithelium, immediately beneath which the mucous membrane consisted of dense, ramifying fibrous tissue which occupied about one-half of the thickness of the ureter. This fibrous tissue spread outward and surrounded and compressed small bundles of longitudinal muscle. These muscles had undergone extensive hyalin degenerative changes. The fibrous tissue continued peripherally to the large and rather dense strands of circular muscle which was the essential peripheral layer of the ureter. These changes were present similarly through all sections.

In the midportion of the ureter the lining epithelium was similarly thick, and the mucous membrane was practically absent. Here the

essential content of the wall was of smooth muscle, three-fourths of which were circular fibers.

Throughout all sections from the vagina upward there was an infiltration of lymphocytes especially into the mucous membrane, and in places the lymphocytes were in clumps adjacent to muscle bundles.

In the ureter, the changes were those of diffuse fibrosis, compression atrophy of longitudinal muscle bundles, and chronic inflammation.

Case 9.—R. M., male, aged twenty months, was admitted October 7, 1931, because of a mass in the abdomen and cramp-like pain at the beginning of urination. At six months of age the infant had pneumonia, and at fourteen months, scarlet fever, during which time he passed blood in the urine. The mother stated that one month prior to admission she first noticed a "lump in the stomach," that it was larger at times and other times could not be felt.

The right kidney was enlarged, irregular in outline and easily palpable. In the midline was felt a suprapubic tumor which was firm and movable and extended 0.5 inch below the umbilicus. On rectal examination, there was a non-fluctuant round mass about the size of a butternut, in the midline (thickened bladder).

Roentgen-ray examination of the genito-urinary tract was negative for stone. Two attempts at intravenous pyelography with skiodan failed to visualize the urinary tract.

The passage of a soft rubber catheter met an obstruction in the prostatic urethra. The obstruction was finally overcome and 180 c.c. of urine were obtained.

Examination of the urine showed three plus albumin, four plus pus, no red cells or casts. Culture of the bladder urine revealed streptococci and staphylococcus aureus.

A cystogram made at this time showed a bilateral hydronephrosis.

Examination of the blood showed red cells 3,800,000, white cells 8,400, hemoglobin 65 per cent, neutrophiles 56 per cent, and lymphocytes 44 per cent. Blood chemistry was N.P.N. 112, creatinin 2, and uric acid 6.5.

The infant ran a septic course. Death occurred on October 22, 1931.

Clinical diagnosis was congenital anomaly of the urinary tract (probably a vesical neck obstruction or valve), with secondary bilateral hydro-ureters and uremia.

Following autopsy October 23, 1931, anatomic diagnosis was congenital valve obstruction of the posterior urethra; median bar obstruction; dilatation and hypertrophy of the bladder; diverticulum of the bladder; bilateral hydro-ureter and hydronephrosis; pressure atrophy of kidneys.

Specimen showed the right kidney was enlarged, its surface was irregular, the cortex thin, the pelvis extremely dilated, with marked hydronephrosis. There were similar changes in the left kidney, but it

was smaller than the right. Both ureters were markedly dilated and the walls were thin. The dilatation extended from the renal pelvis down to the bladder wall. The intramural part of the ureters was not dilated (Fig. 7).

There was great thickening of the bladder wall. An opening of a diverticulum was seen in the upper right quadrant. There was hyper-

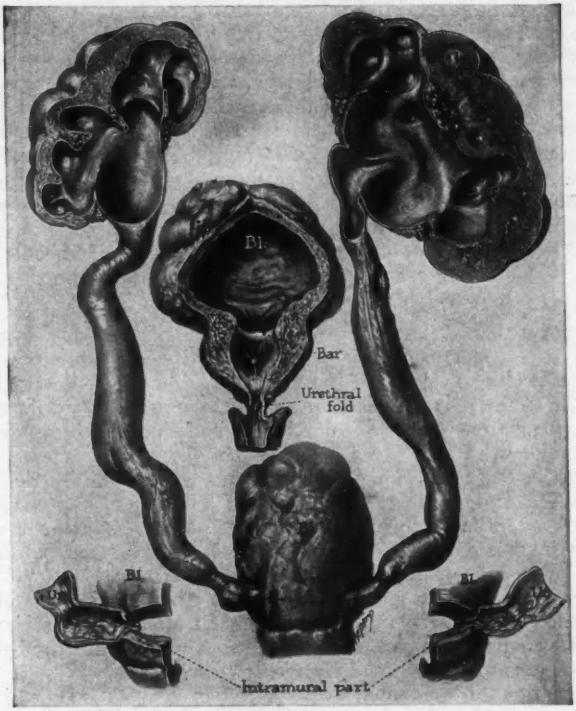

Fig. 7. Case 9. Inserts show dilatation of ureters down to the bladder wall. Intramural part of ureters thickened but not dilated. Note median bar and valve in urethra. Trigone thickened.

trophy of the trigone, and the ureteral openings were normal. The presence of a median bar obstruction was seen. The prostatic urethra was dilated, and in front of it was seen a fold of the mucous membrane.

Histology.—Serial sections were made of the entire lower portion and the midportion of each ureter.

The findings of each ureter were essentially similar. In the intramural portion the lining epithelium was narrow, the mucous membrane normally thick, and the inner circular and outer longitudinal muscle fibers were only normally prominent.

Just above the bladder, however, the ureter diameter and thickness of the wall were markedly increased. The lining epithelium and mucous membrane were narrow. The thickness of the wall was due to a marked increase in the size of the muscle fibers in the large bundles held together by loose connective tissue. At least three-fourths of the thickness of the ureter wall was muscle tissue. Here, in places, the increase of muscle was due to longitudinal fibers in clumps, and on opposite sides of the same block the circular muscle fibers were densely prominent. This variability of muscle prominence was evident throughout all the sections of the lower portions of the ureters.

In the midportion of each ureter there was a uniform hyperplasia of all layers, and not of muscle fibers only. Here the longitudinal fibers were central, the circular fibers peripheral.

In all sections of the ureter there was evidence of chronic inflammation. This was most marked in the mucous membrane.

Case 10.—R. K., male, aged two months, was admitted October 5, 1931, because of frequent projectile vomiting, occurring five to ten minutes after feeding. This symptom had been present since the child was twelve days old. A hard swelling was in the lower abdomen which the mother first noticed three weeks ago; also swelling of the left leg for two weeks. The mother stated that the infant urinated very infrequently.

The patient was a somewhat underweight and mildly dehydrated infant. The abdomen was distended and tense, with dilate superficial veins. A suprapubic tumor, extending 2.5 cm. above the umbilicus, was felt in the lower abdomen. The right kidney was palpated but not the left. There was some edema of the left leg.

The cystogram showed a large, slightly asymmetrical bladder and a markedly dilated left ureter. The right ureter was not visualized. The intravenous pyelogram failed to show any evidence of dye in the kidney regions or along the course of the ureters.

Examination of the blood showed red cells 3,800,000, white cells 18,500, hemoglobin 55 per cent. Blood chemistry was N.P.N. 42, uric acid 5.

Examination of the urine showed albumin, many pus cells, and no casts.

The infant was treated by means of indwelling catheter, but ran a progressively unsatisfactory course, growing more and more dehydrated in spite of the fluids given parenterally. Death occurred on December 31, 1931.

Clinical diagnosis was vesical neck obstruction; bilateral hydroureter with hydronephrosis; uremia; bronchopneumonia.

Following autopsy January 1, 1932, anatomic diagnosis was congenital iris valve of the posterior urethra; dilatation and hypertrophy of the bladder with diverticulum formation; bilateral hydronephrosis; atrophy of the left kidney; bilateral pyelonephritis; hypostatic bronchopneumonia.

Specimen (Fig. 8) revealed the presence of an iris diaphragm in front of the verumontanum. It completely closed the urethra except

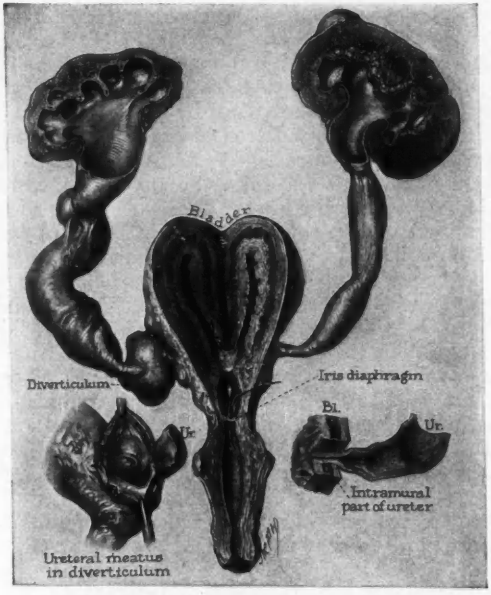

Fig. 8. Case 10. The right ureter empties into a diverticulum. Bladder wall enormously thickened. Iris type of valve in urethra. Intramural part of ureter thickened. Juxtavesical portion of left ureter thickened with dilatation above.

for a pinpoint opening, and the prostatic urethra was somewhat dilated.

The bladder wall was enormously hypertrophied and there was the opening of a diverticulum at the site of the normal insertion of the right ureter. The right ureter opened into this diverticulum, and the right ureteral orifice was normal. Immediately above this diverticulum the ureter was thickened with normal circumference, but above this point it was enormously dilated, twisted, and sacculated. The pelvis was dilated and the kidney showed hydronephrotic atrophy, with

only a small shell of the kidney remaining. The pelvis was 48 mm. in circumference.

The left kidney revealed a cortical abscess and moderate hydronephrosis. It measured 44 × 30 × 26 mm. The pelvis measured 20 mm. in circumference and 27 mm. in length. The lower ureter was thin-walled, tortuous and dilated. At its entrance into the bladder it was thickened and narrowed.

Histology.—Serial sections of the entire lower end of each ureter were made.

In the left ureter in the intramural portion the lining epithelium was thick, and compressed into folds. The mucous membrane was wide and its connective tissue extended peripherally so as to surround small circular muscle fibers, adjacent to which were masses of longitudinal muscle fibers of about uniform size, with poor staining properties. Directly above the bladder, the ureter wall was thick. Its lining epithelium was narrow, the mucous membrane wide. Here the muscle fibers were prominent and were circular and longitudinal in almost equal proportions. The longitudinal fibers were surrounded by dense connective tissue and in a few places some of them stained poorly, similar to what occurs in atrophy. Immediately adjacent, however, the muscle bundles were markedly hypertrophic and some of them were two to three times the usual size. This hypertrophy continued upward to the portion where the dilatation began.

On the right side, at the point of entrance of the ureter into the diverticulum, the lining epithelium was thick. Here there was a definite increase of fibrous tissue throughout the mucous membrane, and in places it compressed or replaced muscle fibers as in stricture. Directly above this part of the ureter, and extending to the dilated part, the muscle fibers, especially the peripheral longitudinal ones, were hypertrophic in similar fashion to those of the left ureter.

Along the entire course of the ureter and into the kidney proper there were extensive changes of acute inflammation.

Case 11.—J. D., male, aged five months, was admitted January 24, 1932, because of the following complaints: Stiff neck of three days' duration, pneumonia for eleven days, fever of 102 to 106 degrees for eighteen days, drowsiness, cough, anorexia for two days, dyspnea for one week, and stiffness of the right arm.

There were no urinary symptoms.

The patient was a well-nourished, acutely ill infant, with labored and irregular respirations. The neck was rigid. There was bulging of both eardrums, an area of dullness over the right chest, anteriorly and posteriorly, and bronchial breathing over the entire chest, most marked over the upper lobe. There were a few coarse râles. The heart was normal except for sinus arrhythmia. The abdomen was negative except for considerable distention.

The spinal fluid showed B. influenzæ in pure culture.

Death occurred ten hours after admission.

Clinical diagnosis was bronchopneumonia; meningitis (influenzal); otitis media.

Following autopsy January 26, 1932, anatomic diagnosis was fibropurulent cerebrospinal leptomeningitis (bacillus influenzæ); cavernous sinus thrombophlebitis; bilateral purulent otitis media; bilateral bron-

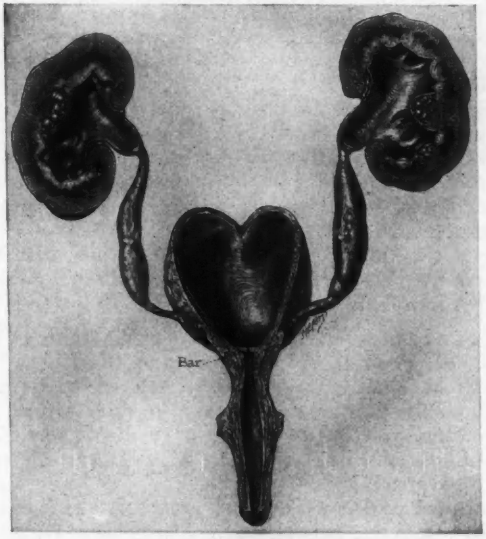

Fig. 9. Case 11. Note the dilatation of the bladder and presence of a median bar with dilatation of ureters above.

chopneumonia; fibrino-purulent right pleuritis (B. influenzæ); serous peritonitis (B. influenzæ); median bar formation; bilateral hydronephrosis.

Specimen (Fig. 9) showed the bladder was dilated, and the wall was thickened uniformly. The presence of a median bar was noted. The ureteral orifices were normal. The lower ends of the ureters were contracted and the lumen was small. The right ureter, at a point 15 mm. above the bladder, was dilated, the dilatation continuing upward to, or nearly to, the ureteropelvic junction. The left ureter showed dilatation at a point about 5 mm. above the bladder, and this dilatation extended to the ureteropelvic junction.

The intramural part of the ureter appeared to be of about the same size and structure as the juxtavesical part.

The kidneys showed moderate hydronephrosis.

Histology.—In serial sections of both ureters, the findings were essentially similar.

In the ureters within the bladder wall the lining epithelium and the mucous membrane were normally wide, the muscle fibers scant.

At the point where the right ureter entered the bladder the mucous membrane was thick and in places ramified by strands of fibrous tissue which surrounded small bundles of centrally-placed longitudinal muscle fibers. As the ureter was followed upward, however, the central longitudinal and peripheral circular muscle fibers were markedly increased in size, and they occupied about three-fifths of the entire ureteral wall.

In the left ureter, from the bladder junction up to the dilated portion of the ureter, the muscle fibers were generally huge. The longitudinal fibers were centrally placed, the circular fibers peripheral. This hypertrophy of muscle is of both types, and may be present in a single section, or in zones as the ureter is followed upward, where one type predominates over the other.

In the upper two-thirds of each ureter the walls were thin. Here the epithelium was narrow, the mucous membrane rather diffusely fibrous and the muscle tissue scanty.

Case 12.—R. O., male, aged six weeks, was admitted December 9, 1927, because of vomiting. At the tenth to twelfth day of life he began to vomit once daily, the vomiting projectile in type. The frequency of the vomiting gradually increased to three to four times daily after each feeding. He began to cough ten days ago. For the past two days breathing had been very rapid. Temperature upon admission was 97 degrees.

The patient was a dehydrated and malnourished child, breathing deeply and very rapidly; no cyanosis. Lungs were negative. There was a systolic murmur at the precordium and apex. The abdomen showed no palpable masses. Extremities were negative. The infant was too ill for a thorough examination.

Examination of the blood showed red cells 2,700,000, white cells 16,900, hemoglobin 36 per cent; neutrophiles 73 per cent; lymphocytes 27 per cent.

No examination of the urine was made.

The following day there was a change for the worse; he vomited dark brown material and a small amount of mucus. Respirations were rapid and gasping, and there were many râles throughout the chest. Pulmonary edema. Death occurred thirty hours after admission.

Clinical diagnosis was pylorospasm; pulmonary edema.

Following autopsy December 11, 1927, anatomic diagnosis was marked bilateral hydro-ureters and hydronephrosis with infection; extensive bilateral bronchopneumonia; emaciation; dehydration; generalized anemia.

Specimen (Fig. 10) showed the bladder was dilated half way to the navel. There was marked dilatation of the ureters, which were thin-walled and had a tortuous course. The pelves were dilated, with marked destruction of the kidney substance. There was marked hydronephrosis. Both ureters were dilated down to the juxtavesical part, at which point the walls of the ureter were extremely thick.

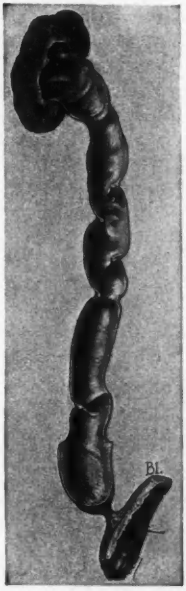

Fig. 10. Case 12. Uniformly dilated thin walled ureter. Intramural and juxtavesical part of the ureter thickened, due to muscle hypertrophy.

The bladder wall was also thickened. Both ureteral orifices were normal. There was no obstruction in the urethra.

Histology.—In serial sections of the right ureter in its lower portion, at and directly above the bladder, the lining epithelium was thin. In large circular strands and in large longitudinal bundles, the muscle fibers completely surrounded the lumen and occupied most of the mucous membrane layer. A few of the large fibers were hyalinized and some had vacuoles in them where the connective tissue was more evident. This hypertrophy was perhaps a little more marked in the

circular muscle fibers. In places, large muscle fibers were present, extending from the lining epithelium to the peripheral connective tissue.

The entire ureter from the juxtavesical portion to the kidney pelvis had a thin wall, composed of all layers, but the mucous membrane was almost completely obliterated. Here all the tissues stained poorly.

Case 13.—W. K., male, aged nine and a half years, was admitted March 7, 1930, because of a swelling of the right side of the scrotum. The swelling had been present for two weeks and had reached the size of a hen's egg. It ruptured and drained for several days, then healed over and remained painful and larger than normal. A similar condition had occurred in the left side of the scrotum a year previously and had drained for four weeks. The left testicle was removed and a diagnosis of tuberculosis was made.

For a month before admission to the hospital the patient had lost weight and his appetite was poor. Since he was five months old he has had a skin affection, first on the buttocks, afterwards becoming gradually generalized.

The urinary stream was very fine and there was obstruction to urination.

The patient was an underdeveloped and poorly nourished child. There was a mucoid discharge from the ears. Teeth were carious and loose. Tonsils were large. Heart and lungs were negative.

The bladder was distended as high as the umbilicus. Pus was oozing from the urethral meatus. The left testicle was absent and there was a small healed sinus on the left side of the scrotum. The right testicle was large, hard, and painful. There was an atrophic condition the skin of the face, and of the extremities and abdomen as far as the umbilicus.

Roentgen-ray examination revealed a sacral spina bifida occulta. An intravenous pyelogram was attempted but was unsuccessful on account of renal insufficiency.

Examination of the blood showed red cells 3,450,000, white cells 10,800, hemoglobin 30 per cent.

Examination of the urine showed a small amount of albumin and an excessive amount of pus cells. Tubercle bacilli were absent. Various tuberculin tests were negative.

Blood chemistry was N.P.N. 84, uric acid 8.6, and creatinin 2.

An abscess in the right scrotal region was incised, the pus of which contained hemolytic streptococci in pure culture.

An indwelling catheter was inserted and operation advised, but the child ran a septic temperature, and became less clear mentally. Death occurred on April 29, 1930.

Clinical diagnosis was chronic urinary retention with renal insufficiency and infection; obstruction of the posterior urethra; acute epididymitis; infantilism and xeroderma.

Following autopsy April 29, 1930, anatomic diagnosis was prostatic abscess producing obstruction of the posterior urethra; purulent cystitis; hypertrophy of the bladder wall; bilateral pyonephrosis and pyelo-

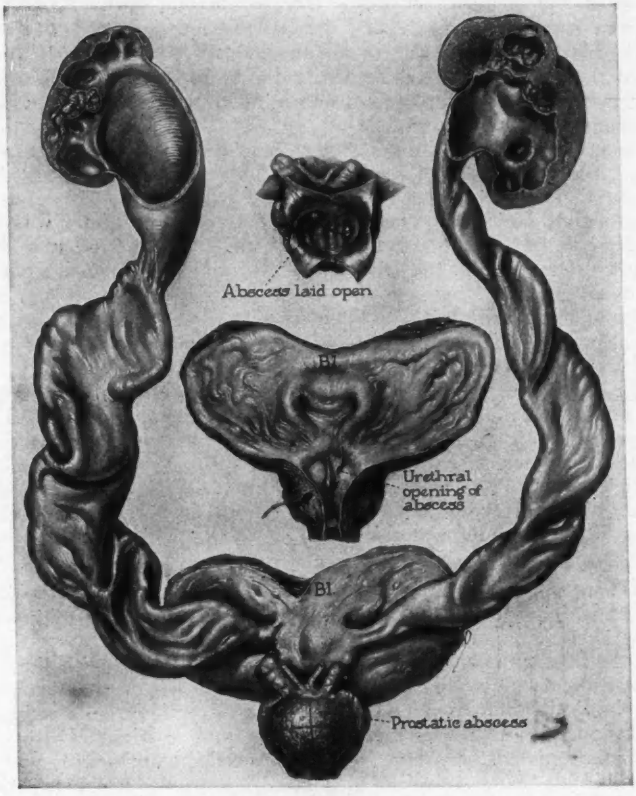

Fig. 11. Case 13. Note enormous thickening and dilatation of ureters beginning above the juxtavesical part. Probe passed through openings of prostatic abscess. Dotted line indicates incisions made in opening the prostatic abscess. Hydronephrosis, bilateral.

nephritis; septicemia (Streptococcus hemolyticus); bronchopneumonia; partial prolapse of the rectum; dwarfism.

Specimen (Fig. 11) showed that the bladder wall was enormously thickened and hypertrophied. There was no evidence of urethral-valve formation or strictures. The ureteral openings themselves were

normal. On the floor of the prostatic urethra, on the left side, was an opening that measured 2 mm. in diameter. A smaller opening measuring 3 mm. was located outside the lining of the mucous membrane of the urethra. A probe inserted in one opening revealed a large cavity in the prostate, and the two previously described openings communicated. The cause for the enormous hypertrophy and thickening of the bladder wall was evidently due to an abscess of the prostate that ruptured into the prostatic urethra, filled up with urine and caused a chronic obstruction.

Examination of the kidneys showed marked hydronephrotic atrophy. Very little kidney tissue remained. The pelvis of the right kidney measured 45 mm. across, and from the edge of the kidney to the ureteropelvic junction, 60 mm. Below this point the ureter was enormously dilated, tortuous, fell on itself and measured 80 mm. in its largest circumference. As the ureter was followed down it gradually narrowed to the juxtavesical portion of the ureter, where it was thickened and hard, and stood out in marked contrast to the thick-walled, dilated portions of the ureter above. The circumference of the ureter here was only 16 mm.

The left kidney was 62 mm. long, 37 mm. wide, and 20 mm. thick. The pelvis was much smaller and measured in its widest part 50 mm. in circumference, and the length down to the ureteropelvic junction is 35 mm. The widest part of the left ureteral wall was not as wide as the right wall, its circumference being 90 mm. The ureter was dilated down to its bladder end, and as the intramural part was dissected out, the wall of the ureter was thick.

Histology.—Serial sections were made of each ureter in the intramural and juxtavesical portions, also of each ureter in its midportion.

The changes in each ureter were essentially similar.

In the bladder wall and directly above it, the lining epithelium and mucous membrane were thin and were the site of extensive subacute and chronic inflammation. Compressing and partially obliterating the mucous membrane were huge masses of muscle fibers which completely surrounded the ureter. Here the predominant muscle was circular, and all fibers stained well. The hypertrophy of muscle tissue was of the entire juxtavesical portions of the ureters up to the point where dilatation began.

In the midportion, the ureter wall was thick, this being due largely to chronic inflammatory hyperplasia. Here the muscle fibers were peripherally located and were about normal size in proportion to the thickness of the wall. These portions stained poorly.

Case 14.—A. H., male, aged twelve days, was admitted March 12, 1932. For the first sixty hours following birth, no urine was passed. Four days before admission to the hospital the amount of urine passed

was very small and voiding was attended with great difficulty. Vomiting occurred for four days.

The patient was a dehydrated infant with poor tissue turgor. There was a purulent nasal discharge. The tongue was dry and heavily coated. There were a few small pustules on the right side of the chest. Rhonchi were heard in all lung areas. A remnant of the umbilical cord was attached.

The bladder was distended up to one fingersbreadth above the navel.

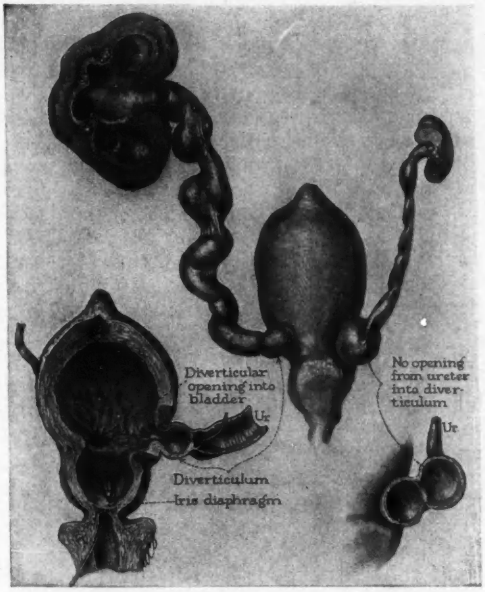

Fig. 12. Case 14. Note blind insertion of right ureter into a diverticulum. Aplasia of right kidney. The left ureter passes behind another diverticulitis. Iris valve in posterior urethra.

Following the catheterization the infant voided frequently small amounts. However, a suprapubic tumor rapidly developed. The size of the bladder greatly increased until it reached nearly to the navel.

Roentgen-ray examination was negative for stone. Intravenous pyelogram was made—no visualization on the right side. On the left side the urogram showed a hydronephrosis and hydro-ureter. The cystogram showed an enlarged bladder.

Examination of the blood showed red cells 6,500,000, white cells 4,700, neutrophiles 37 per cent, and lymphocytes 58.

Voided specimens of urine contained albumin, many red blood cells, no casts; loaded with white blood cells. Von Pirquet tests were negative. Staphylococcus aureus in pure culture was obtained from the blood.

On March 17 the infant began to vomit and an impetigo began to spread. The next day the impetigo became much worse, spreading rapidly, and appeared as a diffuse progressing superficial inflammation from which the skin exfoliated in sheets without the formation of bullæ. Almost the entire body became involved and this was followed quickly by death on March 20.

Clinical diagnosis was congenital bladder neck obstruction; left hydronephrosis and hydro-ureter; exfoliative dermatitis neonatorum (Ritter's disease).

Following autopsy, March 21, 1932, anatomic diagnosis was congenital iris-diaphragm obstruction of the prostatic portion of the urethra; huge hypertrophy and dilatation of the urinary bladder with diverticulum formation; left hydro-ureter and hydronephrosis; acute suppurative urethritis, cystitis, and pyelonephritis (Staphylococcus aureus hemolyticus, Streptococcus hemolyticus); congenital atresia of the right ureter; aplasia of the right kidney; uremia; hypostatic bronchopneumonia; dehydration; emaciation; excoriation of the skin of the perineum; dermatitis exfoliative neonatorum (impetigo); Meckel's diverticulum.

Specimen (Fig. 12) showed the bladder wall was very thick. Near the normal location of the right ureteral orifice was seen the opening of a diverticulum. The right ureter fused with the diverticulum on the right side. The lower end of the right ureter was closed. Both right ureter and kidney showed marked aplasia.

The left ureteral orifice was normal. In front of it was seen the opening of another diverticulum. The intramural portion of the ureter was thickened and above the thickening the ureter was dilated and tortuous. There was a marked left hydronephrosis.

An iris type of valve formation was noted in the posterior urethra.

Histology.—In serial sections of the right ureter which had a blind attachment to a diverticulum of the bladder, from its lower portion to the kidney, the lumen was patent. The ureter wall had a normally thick epithelium, but all of the remainder of the wall was a loose fibrous reticulum extending to the periphery. In this reticulum were small bundles of longitudinal muscle fibers and solitary fibers of circular muscle.

In the kidney there was extensive fibrosis, atrophy of the tubules, and many hyalinized glomerulæ. In one place in the cortex, cartilage was present.

The wall of the diverticulum of the bladder at the lower end of the right ureter had a flat epithelial lining of low cuboid cells. The mucous membrane adjacent was richly vascular, and had changes of sub-

acute inflammation. Here the mucous membrane was thick, occupied about two-thirds of the diverticulum wall, and in the periphery were delicate strands of muscle fibers which stained poorly.

In serial sections of the entire lower part of the left ureter, throughout the entire portion, compressed by a diverticulum of the bladder on this side, the increase in size of the ureter wall was largely due to a huge hypertrophy of muscle fibers. Here the predominant muscle fibers were circular, and were mainly peripheral. In places, three-fourths of the thickness of the wall of the ureter consisted of muscle fibers which surrounded the lumen. At those points where the muscle fibers were less dense the thickness consisted of mucous membrane.

In serial sections of the midportion of the left ureter, the lining epithelium and mucous membrane were narrow. The muscle fibers were scant, and consisted essentially of circular fibers. The wall was thin in comparison with the juxtavesical portion.

Case 15.—W. L., male, aged six weeks, was admitted July 14, 1932, because of a history of diarrhea, fever of twenty-four hours' duration, and anorexia for two weeks. He had been a feeding problem since birth.

The patient was markedly anemic, dehydrated, emaciated, and cyanotic, with rapid and shallow respirations. The head was oddly shaped, the parietal and occipital bones bulging. The fontanels and cranial sutures were widely separated, and here the soft tissues were depressed. The abdomen was distended, tight and bulging at the flanks. There were physical findings of a diffuse bronchopneumonia.

Examination of the blood showed red cells 2,250,000; white cells 51,400; hemoglobin 60 per cent; polymorphonuclears 65 per cent; large lymphocytes 32 per cent; mononuclears 3 per cent.

No urine was obtained, although a test tube was fastened to the penis.

The spinal fluid was under normal pressure, 7 cells per cubic millimeter, and negative to bacterologic culture and Wassermann and Kahn reactions.

There was occult blood in the stools.

Death occurred thirty-one hours after admission.

Clinical diagnosis was intestinal intoxication; bronchopneumonia; decomposition; Mongolianism.

Following autopsy, July 16, 1932, anatomic diagnosis was congenital membranous valve obstruction of the prostatic portion of the urethra; hypertrophy and dilatation of the urinary bladder; hydro-ureter and hydronephrosis; marked compression atrophy of the kidney substance; extensive fibrinopurulent cystitis, ureteritis, and pyelonephritis (B. coli communis); acute hyperemia of the nasopharynx; extensive bilateral bronchopneumonia; hyperplasia of the peribronchial lymph nodes and of the conglomerate lymphoid tissue of the lining of the ileum; hyperplasia of the mesenteric lymph nodes; paralytic ileus; generalized

anemia; dehydration; emaciation; Mongolian idiocy; widely-separated sutures of the cranial bones; phimosis; multiple lumbar spinal needle puncture wounds; multiple subcutaneous hypodermoclysis needle puncture wounds.

The kidneys, ureters, urinary bladder and entire urethra were included in one mass and were carefully dissected. The entire urethra was incised from the glans penis back into the bladder and continued up in front of the bladder to its back portion. The lining of the urethra was normally smooth throughout its entire course, but at the beginning of the prostatic portion of the urethra there was a high linear fold which extended back to the front margin of the verumontanum. In general, this congenital membranous fold of the prostatic urethra was "V" shaped, the apex of the "V" pointing towards the verumontanum. The walls of the fold were thin and easily compressible. It is assumed that urine within the bladder would cause an obstruction at the membranous portion of the prostatic urethra by displacing the fold either to the right or left and thus making a pocket. The "V" shape of the fold would similarly cause difficulty of catheterization from below when the fold was displaced down and laterally by a distended bladder. This fold of the prostatic portion of the urethra occupied almost the entire caliber of the urethra at this point. The verumontanum was about twice its usual size, and the urinary bladder wall adjacent was thickened, as was that of the body of the urinary bladder generally. The lining of the urinary bladder was coarsely trabeculated. The intramural portions of each ureter were narrow, and directly above the bladder, each ureter, uniformly for a distance of 20 mm. was markedly contracted into a narrow firm tube. The right ureter in this juxtavesical portion was cord-like. Both ureters, 20 mm. above the bladder, were markedly and uniformly dilated and slightly sacculated throughout their entire length. The pelves of both kidneys were dilated so that they were at least three to four times the usual size. Hydronephrosis was more marked on the left side. In surfaces made by cutting the kidneys there was hydronephrotic atrophy so that the cortex was, in most places, only 5 to 7 mm. thick. At least one-third of the kidney substance had been destroyed. The content of the kidney pelves, ureters, and bladder consisted of purulent urine.

Histology.—In serial sections of the entire lower one-third of each ureter from the intramural portions upward, the changes of each ureter were essentially identical.

Within the bladder wall, the epithelial lining was narrow, the connective tissue of the mucous membrane was normally thick and homogeneous. Here longitudinal muscle bundles were present and some of them had changes of atrophy. Circular muscle fibers were scant. In the peripheral portions of the ureter here, the longitudinal muscle

fibers were huge and extended laterally to blend with those of the bladder wall.

Adjacent to the bladder wall, and for 20 mm. upward, the mucous membrane became narrow and within it and peripherally to it, the longitudinal fibers were so abundant as to occupy three-fourths of the thickness of the wall. Strands of circular muscle fibers ramified around these longitudinal bundles.

Above this juxtavesical portion, the epithelium was more abundant, the mucous membrane connective tissue was less compact, and as the ureter was traced upward, the narrow, densely muscular juxtavesical portion gradually dilated. Here the circular muscle fibers were the predominant muscle. At about the middle third of the ureter and up to the kidney the wall was thin. This atrophy was of all layers but especially of the mucous membrane.

From the bladder upward to the kidneys on both sides there was subacute inflammation which was present throughout the ureter but especially in the mucous membrane.

In reviewing this series of cases we note that twelve patients were males and three were females. The youngest child was one month and the oldest ten years, and nine were under seven months of age. The clinical diagnoses were exceedingly interesting and showed, in a large majority, that the urologic condition was not recognized. This was, in part, due to the fact that some of the patients were seen in the pre-urologic days of pediatrics and also due to the fact that some of the patients entered the hospital practically in extremis so that a complete study was not possible. On the other hand it is exceedingly interesting to note the accuracy of the urologic diagnoses in the recent cases since the establishment of the urological service, since which time the attention of the general services has been directed to the possibility of these various lesions so that the diagnoses were made before the cases were referred to the urological service.

A detailed summary of the ages, sex, clinical diagnoses, with a brief résumé of the autopsy findings, is given in the accompanying table.

An analysis of this group shows that the underlying pathology was essentially obstructive in nature and that in most of the cases the obstruction was congenital in origin. In this group were found the presence of congenital valves in the posterior urethra, the presence of median bars, the presence of diverticula with the ureters inserted into the diverticulum.

SUMMARY

Case No.	Age	Sex	Clinical Diagnosis	Urologic Conditi
1	1 mo.	Male	Pyloric obstruction	Not recognize
2	1 yr.	Male	Spina bifida; fractured femur; talipes equinovalgus	Not recognize
3	11 mos.	Male	Alimentary intoxication	Not recognize
4	4 yrs.	Male	Acute pyelocystitis	Not recognize
5	5½ mos.	Female	Exstrophy of bladder; acute pyelonephritis	Not recognize
6	8½ yrs.	Female	Uremia; pyelonephritis; post-diphtheritic paralysis	Not recognize
7	6½ mos.	Male	Bronchopneumonia; extreme atrophy	Not recognize
8	1½ mos.	Female	Gastroenteritis	Not recognize
9	1¼ yrs.	Male	Congenital anomaly of urinary tract—probably vesical neck obstruction or valve—with hydroureters and uremia	Recognized
10	3 mos.	Male	Vesical neck obstruction with hydroureter and hydronephrosis	Recognized
11	5 mos.	Male	Bronchopneumonia; meningitis	Not recognize
12	6 wks.	Male	Pylorospasm; pulmonary edema	Not recognize
13	10 yrs.	Male	Obstruction of posterior urethra; chronic urinary retention with renal insufficiency and infection	Recognized
14	12 days	Male	Congenital bladder neck obstruction; left hydronephrosis and hydroureter; exfoliate dermatitis	Recognized
15	2 mos.	Male	Intestinal intoxication; bronchopneumonia	Not recognize

UMMARY OF CASES REPORTED

gic Condition	Cause of Death	Autopsy Findings
recognized	chopneumonia	Congenital valve in posterior urethra; hypertrophy and dilatation of urinary bladder; hydroureter and hydronephrosis, bilateral.
recognized	chopneumonia	Spina bifida; horseshoe-shape kidney; hydroureters and hydronephrosis.
recognized	ntary intoxication	Ectopic right kidney; hydroureter and hydronephrosis, left diverticulum of bladder; emaciation and anemia.
recognized	remia	Congenital valve in posterior urethra; median bar; hypertrophy of bladder wall; chronic cystitis; bilateral hydronephrosis; dilatation of ureters; multiple abscesses of kidneys.
recognized	chopneumonia	Exstrophy of bladder; subacute cystitis and urethritis; empyema; ventral hernia.
recognized	ia	Bilateral hydroureters; chronic ureteritis; chronic diffuse nephritis; caseous and calcified tuberculosis of lungs; parabronchial and mesenteric lymph glands.
recognized	chopneumonia; atrophy	Ectopic right kidney; congenital stenosis of left ureter; hydroureter and hydronephrosis.
recognized	venteritis	Ectopic right ureter ending in vagina; bilateral duplication of kidney pelves and ureters; pyoureter and pyonephrosis of upper half of double right kidney.
cognized	ia	Congenital valve of posterior urethra; median bar; dilatation and hypertrophy of bladder; diverticulum of bladder; bilateral hydroureter and hydronephrosis.
cognized	chopneumonia	Congenital iris valve of posterior urethra; bladder diverticulum; bilateral hydronephrosis; atrophy of left kidney; bilateral pyelonephritis; hypostatic bronchopneumonia.
recognized	chopneumonia; gitis (B. influenza)	Median bar formation; bilateral hydronephrosis; fibropurulent cerebrospinal leptomeningitis; cavernous sinus thrombophlebitis; bilateral purulent otitis media; bilateral bronchopneumonia; fibrino-purulent rt. pleuritis; serous peritonitis.
recognized	chopneumonia	Marked bilateral hydroureters and hydronephrosis with infection; extensive bilateral bronchopneumonia; emaciation; dehydration.
cognized	remia	Prostatic abscess producing obstruction of posterior urethra; purulent cystitis; hypertrophy of bladder wall; bilateral pyonephrosis and pyelonephritis; septicemia (streptococcus hemolyticus); bronchopneumonia; partial prolapse of the rectum.
cognized	remia	Congenital iris-diaphragm of prostatic urethra; hypertrophy and dilatation of urinary bladder with diverticulum formation; left hydroureter and hydronephrosis; acute suppurative urethritis and pyelonephritis; congenital atresia of right ureter; aplasia of right kidney.
recognized	chopneumonia	Congenital valve of prostatic urethra; marked hydroureter and hydronephrosis; fibrinopurulent cystitis; ureteritis and pyelonephritis; bilateral bronchopneumonia; paralytic ileus.

The presence of obstruction soon leads to urinary stasis and dilatation, and these patients are prone to urinary infections. The infections may follow the onset of an acute infectious process elsewhere in the body, as, for example, an acute upper respiratory infection, diarrhea, or one of the acute infectious diseases such as measles; or infection may follow the passage of sounds, catheters and cystoscopes.

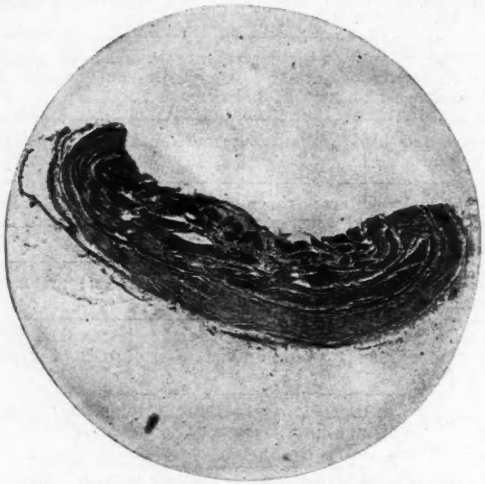

Fig. 13. Marked hypertrophy and hyperplasia of muscle bundles. (Mucous membrane removed.)

HISTOLOGY

Histological studies were carried out in coronal serial sections of the entire intramural and juxtavesical portions of the ureter as well as all other parts of the ureter that showed gross abnormality. Hematoxylin and eosin, Van Giesen and Weigert stains were used.

As a result of these studies, we found that the obstruction in the vesical end of the ureter, in twelve cases, was due predominantly to hypertrophy of muscle, most of which was of the longitudinal fibers. For purposes of comparison a series of normal ureters were removed at autopsy and similar serial sections were made.

In three of the cases, instead of muscle hypertophy, the lower ends of the ureter showed changes compatible with fibrous or true

stricture. In this group there was a predominance of scar tissue which replaced the normal muscle to a very large degree, so that we had no difficulty in differentiating between these two types of lesions. In these cases of true fibrous stricture we found an anomalous insertion of the ureter in three cases; in one, a double kidney, one ureter terminating in the vagina; in two cases the ureter terminated in a diverticulum; in one the end of the ureter that was inserted in the diverticulum was completely closed by scar formation.

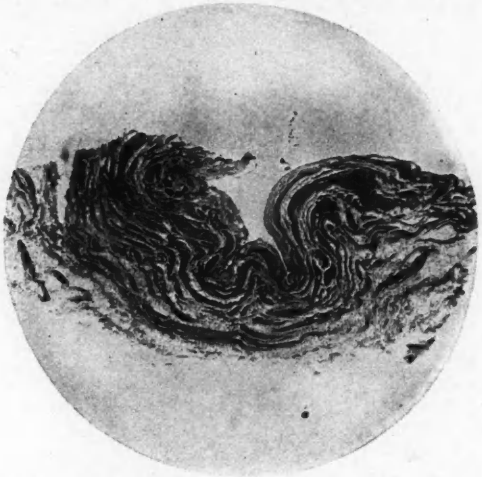

Fig. 14. Typical hypertrophy of the tunica muscularis (mucous membrane removed).

In seeking an explanation for the presence of the hydronephrosis these cases fall in three groups.

In the first group the hydronephroses were due to the presence of a true fibrous stricture of the ureter and here we note the presence of an anomalous insertion of the ureter in the three cases. In one case the accessory ureter with fibrous stricture was inserted in the vagina. In the remaining two cases the ureter terminated in a diverticulum.

In eleven cases of hydronephrosis the obstruction in the ureter was due to extensive hypertrophy of the muscular coat of the ureter and this involved, chiefly, the longitudinal fibers. It is exceedingly interesting to note that this hypertrophy was associated

with obstructive lesions at or in front of the vesical orifice, such as median bars (three cases), the presence of congenital valves in the urethra (six cases), and in one case, due to an abscess in the prostate that produced obstruction to urination (Case 13).

It would appear, therefore, that the muscular hypertrophy was directly associated with the presence of the obstruction. The explanation for the hypertrophy can be readily explained on an anatomical basis.

Fig. 15. Hypertrophy of longitudinal muscle fibers of the lower end of a ureter. (Hematoxylin and eosin stain.)

In 1812, Sir Charles Bell called attention to the fact that some of the muscle bundles of the ureter descend from the orifices of the ureter towards the orifice of the bladder. Here the fibers from each side unite and run toward the prostate. The longitudinal fibers are also known as Bell's muscles. Some of the ureteral fibers pass medially to form the interureteric ligament or Mercier's bar.

These findings were verified by Ellis in 1858.

As is well known, in certain obstructions, for example in benign hypertrophy of the prostate, it is not uncommon to find hypertrophy of the trigone.

Wesson has recently studied the musculature of the trigone.

According to his studies, the original muscle is a definite entity arising from the longitudinal muscle bundles of the ureters and is superimposed on the muscles of the bladder wall. He furthermore stated that the trigonal muscle plays an active part in the process of micturition, pulling open mechanically the internal vesical orifice.

From these anatomical facts we believe that the hypertrophy of the muscle bundles found in the lower end of the ureters in this group of cases was the hypertrophy of overwork in an attempt to overcome the obstruction at or in front of the bladder.

Fig. 16. Hypertrophy of muscle fibers of lower end of the ureter. (Van Giesen stain.)

In one case of muscle hypertrophy the autopsy records fail to state whether or not obstruction was present at or in front of the bladder orifice, but this we believe was present. Only the part of the bladder wall around the ureter was present in the museum specimen.

In two remaining cases no mechanical obstruction was noted; namely, in the case of ectopia of the bladder and in the case of extensive postdiphtheritic paralysis. The muscle hypertrophy here was probably due to disturbed physiology in the one case (ectopic

bladder) and due to disturbed physiology secondary to disturbance in the nervous mechanism following the diphtheritic paralysis.

SUMMARY

1. Stricture of the ureter, in the generally accepted terms, producing hydro-ureter and hydronephrosis, was present in only three patients, all of whom had an anomalous insertion of the ureter.

2. In the remaining twelve cases, the obstruction was due to hypertrophy of the muscular coat of the ureter (longitudinal fibers).

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URETEROCERVICAL FISTULA WITH RE-IMPLANTATION OF THE URETER

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Injury to the ureters incidental to surgical procedure in the pelvic region is not an uncommon accident. While it might seem that the lessening number of operations now done for uterine carcinoma would decrease the frequency of these unfortunate occurrences, yet the increasing number of pelvic operations of other types now being done has resulted in an actual if not relative increase of cases of ureteral damage. Sampson reported thirty-two cases in 1902, Barney sixty-two cases in 1912, Oeconomos 159 cases in 1914. In 1925 Bland reported 441 cases, of which eighty involved both sides and 361 one side alone. Having personally seen, within the last three years, one case of double ligation of the ureters, one of bilateral severance, one of uretero-vaginal fistula and one of ureterocervical fistula, all occurring in pelvic operations unassociated with cancer, I am led to believe that these accidents are far from rare. How many cases of unilateral ureteral ligation have gone unrecognized one will never know. Bilateral injuries, with or without subsequent fistula, manifest their signs all too plainly and, while never unrecognized, may go unreported.

Ureteral damage is the most frequent and serious accident in pelvic surgery, serious because it carries a high mortality rate and is often associated with kidney destruction. That these accidents will continue to occur there is no doubt. Even where the ureters are properly identified and isolated during the preliminary steps of a difficult pelvic operation, sudden loss of a clear field, due to hemorrhage, may obliterate all landmarks and then the ureter runs the hazard of the innocent bystander. Even the use of indwelling catheters is no insurance against this accident for cases are on record where the ureter has been clamped and the intraureteric catheter broken. The anatomic position of the ureters makes them a potential hazard in all operations performed in the pelvic cavity. No section of the tube is free from danger. Even in the renal region damage has been inflicted either as a result of ligation or clamping.

The section above the brim of the pelvis in the region of the appendix has been injured. The part most frequently injured, however, is that extending from the brim of the pelvis to the vesico-ureteral junction.

Accidental injury to the ureters may be inflicted by ligature, clamp or knife. Events developing subsequent to ligation depend upon whether one or both ureters are ligated and the length of time elapsing before remedial measures are instituted. Unilateral ligation produces no more clinical evidence than tachycardia and pain and tenderness over the loin of the affected side. Unless the kidney be an infected one or a fistula develop subsequent to the operation, the accident may easily be overlooked.

Animal experimentation has shown that dilation of the ureter and the pelvis of the kidney begins at once after ligation, followed by a gradual failure of kidney function which becomes complete at the end of four or five weeks. The time within which restoration to normal may occur is set by Johnson from animal experiments at two weeks from the time of ligation. This is approximately true in man, for in a case in which both ureters were ligated, reported by Caulk and Fisher, double nephrostomy on the eighth day was followed by complete restoration of kidney function and the passage of urine by the bladder on the fifty-eighth day.

Corbett found in his experimental work that the results of atresia of the ureter were not always the same. These facts, however, were found:

1. Severe destruction of the kidney almost always results after prolonged obstruction.

2. To save anywhere near the full functional capacity of the kidney this obstruction must be removed not later than six to ten days.

3. Beyond twenty-four days the removal of the kidney seems justifiable for the function of the organ is practically destroyed.

Scott found that complete and incomplete ligation of the ureter will produce hydronephrosis, the degree depending upon the duration of the obstruction. Complete obstruction produces hydronephrosis more rapidly than an incomplete one. The microscopic changes in the kidney are the same in complete and incomplete obstructions.

The amount of damage done to the ureter at the site of ligation

seems to be directly proportionate to the length of time the ligature remains in place, to the type of ligature used and to whether the ligatures are single or multiple. Intentional ligation of the ureter in animal experiments results in greater local damage than occurs in accidental ligation during the operation where more or less surrounding tissues are included in the ligatures. Kolb removed a ligature, accidentally applied, after twenty-four hours, and at autopsy shortly after there was no evidence of necrosis at the point of previous ligature.

Injury by clamps, while somewhat rarer, results in greater damage over a larger area. The result is either local necrosis with fistula formation or a more or less complete stricture.

Injury by a suture needle may be by direct insertion through the wall of the ureter or by catching the peri-ureteral tissue in such a way as to cause an acute angle in the line of the ureter and thus block the outflow.

Injury by the knife is usually detected during the course of the operation. Either the escape of urine or a tube which refuses to bleed leads one to investigate and recognize the defect.

TREATMENT

The failure of a patient to pass urine after a pelvic operation implies that both ureters have been tied, severed or caught in such a way as to cause a complete block. How then shall we proceed? Shall we again open the abdomen of a patient who has within a day or two undergone a serious operation and proceed to isolate the ureters, to search for one or more ligatures, or to find one or both ureters severed? Our first problem is to establish a urinary outlet with the least possible danger to the patient. The renal pelvis can be exposed very easily under local or light general anesthesia and a longitudinal incision 2 cm. in length is made in the pelvis or upper ureter without dislodging the kidney. It is not necessary to place a tube directly into the pelvis, for, as long as the obstruction remains below, the urine will continue to drain through the incision in the loin. A drainage tube through the muscles and fascia is necessary, however, to give free access to the outside. While the patient is recovering from the pelviostomy, the progress and extent of the ureteral injury can be watched with safety.

A severed ureter if recognized at the operation, may be repaired

if the distal portion is of sufficient length, or, if it is not, then the proximal portion may be implanted into the bladder. The two ends of the severed ureter are threaded on a catheter. This catheter is brought out of the ureter through an incision made in it some distance above the line of sutures. Through the same incision a second catheter is passed toward the pelvis of the kidney—to provide for constant drainage of urine and to insure that the line of sutures is kept dry. This method has been used clinically by McArthur and has been proven by Crowe and Bump in their experimental work to give satisfactory results without subsequent stricture.

I wish to report a case of unilateral ureteral injury caused by a clamp or, more likely, by a suture needle, which resulted in a rather unusual fistula forming between the ureter and the cervix uteri. The injury was unsuspected at the time of the operation and was not recognized until the ninth postoperative day when urine began to drain through the vagina.

CASE REPORT

The patient, married woman of forty-four years, white, was admitted to Lakeside Hospital March 18, 1929, complaining of irregular frequent menstruation. Diagnosis of a large uterine fibroid was made. The general condition of the patient was good with the exception of a marked secondary anemia. Blood pressure was 140 systolic, 80 diastolic; hemoglobin 50 per cent; red cells 2,900,000; white count 7,200.

On the day following admission to the hospital the patient was given a transfusion of 500 c.c. of whole blood. On the second day following admittance a supravaginal hysterectomy was performed by an experienced and competent surgeon. The operation went smoothly; the ureters were isolated and identified; the only difficult part of the operation was the supravaginal amputation of the cervix and this difficulty was due to the fact that a small fibroid was present in the cervix on the right side. The immediate postoperative course of this patient was uneventful until the ninth day, when she began to dribble urine from the vagina. At this time, although she voided frequently, she persisted in dribbling at intervals between urination. The temperature at no time was above 101. Pulse ranged between 92 and 100. There was no vomiting nor was there any pain referable to the kidney region. She was permitted up in a wheel chair on the fourteenth postoperative day. On the seventeenth postoperative day a cystoscopy was performed.

Cystoscopic note: The urine was quite cloudy and the bladder required four washings before a clear field could be obtained. There was considerable inflammation of the bladder, especially at the base.

No artificial opening in the bladder was present. The ureteral orifices were irregularly placed, the left one being much higher than the right. The cystoscope was then withdrawn, the bladder emptied, and 150 c.c. of methylene blue was injected into the bladder. The vaginal speculum revealed that the vagina was filled with urine and clear urine could be seen coming from the cervix, but no methylene blue appeared. The dye was then evacuated from the bladder, the bladder washed and the ureters catheterized. The left ureter could be catheterized to the kidney pelvis without meeting any obstruction. The right ureter presented an impassable obstruction 3 cm. from the bladder. The dye was then injected up the left ureter and the vaginal speculum inserted; still clear urine drained from the cervix. The dye was then injected into the right ureter as far as the catheter could be inserted; no sign of any methylene blue came from the cervix. No urine was obtained from the ureter on the right side. A diagnosis of ureterocervical fistula of the right side was made.

After a period of convalescence at home the patient was re-admitted to Lakeside Hospital on May 16, 1929. A re-examination revealed the condition of ureterocervical fistula to be essentially the same. There was, however, less infection in the bladder. A function test of the left kidney made at this time showed the left kidney to be in good condition and of normal function. The urine from the cervix was perfectly clear. There was no pain or tenderness at any time over the right kidney.

On May 20, 1929, four days after her second admission to the hospital, the patient was placed in the Trendelenburg position with the right side elevated. A small sound with an olive tip was inserted into the bladder. Under gas oxygen and ether a midline incision was made through the old scar. The abdomen was opened and in the region of the amputated stump of the cervix on the right side was found an inflammatory mass consisting of a loop of the sigmoid, the broad ligament and the right ureter. The sigmoid was dissected free from the mass, exposing the fistula extending from the cervical canal into the medial side of the ureter. The ureter had not been divided, as far as could be established. The fistulous tract entered the ureter through a small opening about 5 mm. in diameter. Owing to the inflammatory reaction about the fistulous tract it was considered impossible to close it, consequently the ureter was dissected free for a distance of about 3 inches, care being taken not to interfere with its accompanying blood supply. The ureter was then divided across at the level of the fistulous opening and the end was slit. An assistant made pressure on the sound in the urethra, pushing the bladder up into the field of operation so that it was easily identified. The bladder was opened over the point of the sound. A linen suture passed through the extreme tip of the ureter was then tied to the sound and withdrawn through the urethra. There was plenty of slack and the ureter was easily drawn

into the bladder by traction on the suture extending out through the urethra; the cut ends of the ureter were fastened to the bladder wall by means of two mattress sutures of No. 00 chromic catgut. The bladder opening was closed around the ureter and four interrupted sutures of fine chromic catgut were used to anchor the ureter to the bladder wall. When the implant was completed, fully one-eighth of an inch of the ureter protruded into the bladder. The peritoneum was carefully closed around the implant and the abdominal wound approximated in the usual manner. Two cigarette drains were introduced into the depth of the pelvic cavity.

Following the operation the patient was nauseated and vomited occasionally for a period of two days. The bladder was kept on constant drainage by means of an indwelling catheter inserted through the urethra. The wound drained a very slight amount of urine for four days following the operation and then subsided completely. The patient was permitted up in a wheel chair on the fifteenth day and was discharged two days later. The linen suture which was fastened onto the intravesical portion of the ureter sloughed off on the seventh day and was removed.

This patient continued well and was last seen March 5, 1930. At that time she had no symptoms of any discomfort whatever; her general health was good. A cystoscopy revealed clear urine and no inflammation of the bladder. The right ureteral orifice protruded like a small bud; it was quite high in the fundus on the right side, was almost round and about twice the size of a normal ureteral opening. Due to the position of the implanted ureter in the loose portion of the bladder, no catheter could be inserted. Clear urine, however, was seen coming from the right side.

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THE DIFFERENTIAL DIAGNOSIS OF RENAL TUMORS

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(by invitation)

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When one undertakes the differential diagnosis of renal tumors he views the question more from the clinical standpoint than from that of the pathologic laboratory. Their origin is interesting but is, to the investigator, not a vital point, but it is of importance if, prior to operative treatment, one can find out the nature of the growth as a guide to the procedure to be adopted and the prognosis that will attend it.

The problem that first confronts one is whether a growth is present, for, if so, nephrectomy will be indicated if the disease is confined to that organ and another healthy kidney exists.

The delineation of the form and capacity of the renal pelvis and ureter by infusion urography goes far to answer these questions. Probably the greatest triumph it has achieved has been in enabling us to recognize tumors of the kidney at an early stage, and thus permit of treatment being carried out with much less risk to life and a greatly enhanced prospect of effecting a complete and lasting cure.

Some years ago there came under my care a man who illustrated this in a most dramatic manner. He was sixty-four years of age and came to me with a history of simple prostatic hypertrophy, the presence of which was confirmed at the clinical examination. Recently he had suffered from occasional hematuria. The customary cystoscopic examination was made, and 6 ounces of residual urine were found to be present. The prostate gland showed marked intravesical herniation but there was no ulceration over the summit of the gland where it projected into the bladder cavity. A view of the ureteral orifices was just obtained over the mound projecting into the bladder, and from the orifice on the right side slightly blood-stained urine was observed to be escaping. Ureteral catheterization was carried out with difficulty owing to the intravesical protrusion, and subsequently a pyelographic examination was made. This showed signs of an early carcinoma involving the middle of the kidney, and naturally therefore this was first of all operated on. When exposed by operation the kidney appeared normal in every respect except that its consistence was firmer than usual in

the middle. As we were confident, however, of our pyelographic findings, nephrectomy was performed, and later when the kidney was sectioned an early epidermoid carcinoma was revealed in the situation diagnosed and obliterating the middle calix, as had been demonstrated pyelographically. Subsequently the prostate was treated.

This case provides an excellent demonstration of the value of a routine cystoscopic examination in all cases of prostatism, the importance of localizing the source of bleeding in all cases of hematuria, and the diagnostic value of pyelography in revealing early malignant disease of the kidney.

In recent years there has been added to our aids to diagnosis the method of excretion urography. It undoubtedly is a vigorous child that promises to attain to a robust and useful manhood, but at present, I regret to say, it is suffering from the ailments of infancy, for which its parents are largely to blame. The initial misfortune was the name of intravenous urography given to it at its christening. More serious still, it has been recommended as a substitute for infusion urography, and some who are incapable of carrying out an ordinary pyelographic examination are being persuaded to use it instead, with results that are sometimes ludicrous and occasionally disastrous, the truth being, of course, that excretion urography is not a substitute for infusion urography but a most valuable complement to it, with its own independent sphere of utility. By infusion urography a demonstration is obtained of the morbid anatomy of the organs examined; it delineates contour. Excretion urography is a physiologic test; it delineates function in the living and affords an ocular demonstration of renal function, the exact efficiency of which can be further controlled by estimating the amount of the drug excreted and its rate of discharge. Its value as a diagnostic aid in the detection of the presence of a renal tumor is negligible but, as I hope to show, when used in conjunction with infusion urography in such cases, it is of great value in enabling a more accurate differential diagnosis of the type of tumor to be made.

CLASSIFICATION OF RENAL TUMORS

Until the cause of tumor formation and growth is revealed, no satisfactory permanent classification of them will be evolved. In the meantime it is important for us as clinicians to talk a common language as far as possible, and to avoid confusing the issue by the introduction of new terminology. We will accept at the outset the

broad clinical subdivision into innocent and malignant tumors, with the proviso that all innocent tumors of the kidney possess the potentiality of ultimately becoming malignant and that thus tumors of the borderland are encountered.

When, however, we next turn to the site of origin to provide an anatomic basis for further classification we are on more difficult ground, for, as Nicholson remarks, "A tumor in the kidney is not necessarily a tumor of the kidney, in the opinion of the morbid anatomist at least who assumed until recently that this organ is singularly incapable of producing its own tumors, and that nearly all, if not all, renal new growths originate in extraneous tissue, be these the result of displacement or of local arrest of development at an early stage."

The following classification will be generally accepted:

I. *Primary Renal Tumors.*
   1. of epithelial type.
      1. papilloma of pelvis,
      2. papillary carcinoma of pelvis,
      3. epidermoid carcinoma of pelvis,
      4. adenoma,
      5. papillary adenocarcinoma,
         (a) with clear cells,
         (b) with granular cells.
      6. alveolar adenocarcinoma.
   2. of connective tissue origin.
      1. fibroma,
      2. lipoma,
      3. myxoma,
      4. angioma,
      5. sarcoma.
   3. tumor due to developmental abnormality.
      1. mixed tumor (embryonal adenomyosarcoma),
      2. hypernephroma (renal tumors of adrenal tissue).
   4. of perinephric fat and connective tissue origin.
      1. lipoma,
      2. fibroma,
      3. sarcoma.

II. *Secondary Tumors.*
   1. melanocarcinoma,
   2. squamous celled carcinoma,
   3. granular carcinoma,
   4. sarcoma.

Certain of these are of rare occurrence, and others, such as the fibroma, although commonly met in the postmortem room, are, from the clinical standpoint, of no significance. The tumors with which the clinician especially has to deal are:

1. Papilloma of the pelvis
2. Papillary carcinoma of the pelvis
3. Epidermoid carcinoma of the pelvis
4. Papillary adenocarcinoma, with clear cells (which at one time was classified as a hypernephroma)
5. Papillary carcinoma, with granular cells
6. Alveolar adenocarcinoma
7. Angioma (as an occasional cause of hemorrhage)
8. Mixed tumor or embryonal adeno-myosarcoma of infants
9. Hypernephroma (if we still allow that such exists)

THE MORBID ANATOMY OF RENAL TUMORS FROM THE STANDPOINT OF THEIR CLINICAL DIAGNOSIS

The renal tumors mentioned all have certain common characteristics. Thus they may produce a palpable enlargement of the kidney or cause blood to appear in the urine, but at the same time most of them have features which if recognized enable their presence to be identified clinically.

Papilloma of the Renal Pelvis.—This is a benign tumor which affects any portion of the renal pelvis and ureter, and readily grafts onto the urinary bladder. Thus, when a papilloma of the urinary bladder is seen it may be a secondary manifestation and the possibility of a primary renal origin must be borne in mind. The papilloma of the renal pelvis being an innocent tumor, it does not invade the renal parenchyma. Thus on pyelographic examination the contour may be normal. The density of the tumor, however, is less than that of the pyelographic media, and thus the presence of the villi within the pelvis can be outlined. The renal parenchyma being healthy, by excretion urography a kidney of normal func-

tional activity is graphically demonstrated and the rate and amount of the excretion of the drug is also normal. The presence of a papilloma in the renal pelvis renders the assumption justifiable that secondary tumors may be situated within the ureter, and thus the entire removal of the ureter is indicated, especially as such tumors may be situated within its lumen without being palpable from without or causing visible obstruction. If recurrence of the bleeding takes place after nephrectomy for a papilloma of the renal pelvis, without excision of the ureter, and the bladder is found on cystoscopic examination to be healthy, probably the source of the bleeding will be found in the stump of the ureter.

Malignant Papilloma.—This forms a sessile growth of greater density. It occupies a portion of the pelvis, and thus on pyelographic examination a filling defect of this cavity is revealed. The growth invades the renal parenchyma locally, and thus at this examination there is also seen evidence of local obliteration of the drainage system of the kidney in that region. The remainder of the kidney is functionally active as determined by excretion urography.

Epidermoid Carcinoma (sometimes called papillary epithelioma).—Although all cases of epidermoid carcinoma are not associated with calculi or leukoplakia, a previous history of persistent irritation of the renal pelvis is significant. The change produced is akin to an epitheliomatous ulceration of the skin, the mouth or the tongue, in that a superficial ulceration is present on the pelvic surface and the parenchyma is invaded locally and the more distant portion infiltrated. The features observed on pyelographic examination thus are only a slight alteration of the pelvic contour, but evident obliteration of the adjacent drainage system of the kidney. The adjacent calices are not flattened and elongated but may appear to be of normal contour by infusion urography. When examined by excretion urography, however, the renal functional activity is poor and no shadow, or only a faint shadow, may be observed.

Papillary Adenocarcinoma.—These tumors are much the most frequent of renal growths: "Most of them are recorded in the literature as hypernephromata, so that statistical data regarding them are scanty and unreliable" (Ewing). It is especially the papillary carcinoma with clear cells which has been classified as

hypernephroma. We thus must first determine where we stand as regards hypernephroma as a definite and separate clinical entity arising from an adrenal rest. Many now go so far as to dispute its actual existence, and Nicholson in his Studies on Tumor Formation concludes his very able and lucid consideration of the question as follows:

"Although Grawitz's theory may not have been disproved to the satisfaction of everyone, I submit that it has most certainly not been established, and that a tumor of the kidney has yet to be described, whose structure and behavior are the same as those of the epithelial neoplasms of the suprarenal cortex. Renal hypernephromata do not indicate that accessory suprarenals, which are found with a greater or lesser degree of frequency over a comparatively wide area of the body, are predisposed to tumor formation. The only case that satisfied the requirements of a genuine epithelial tumor of an accessory suprarenal is that of Bovin. It was found, not in the kidney, but in the broad ligament of a woman of twenty-eight, who for nine years had suffered from symptoms of suprarenal virilism, which improved after removal of the tumor. Should such a neoplasm ever be described in a kidney, let us hope that it will be in a child, or in a woman before the onset of the menopause."

You will observe that Nicholson doubts their existence but you will note that he acknowledges that accessory suprarenals are found with a greater or lesser degree of frequency over a comparatively wide area of the body. We may be in agreement that these adrenal rests are not predisposed to tumor formation but at the same time it must be acknowledged that they may be the site of tumor formation unless you are going to claim for them a fortunate immunity from neoplastic disease such as no other tissue in the body possesses. I do not ask you to accept Cohnheim's theory but only the law of average. You will also observe that he will accept as a genuine hypernephroma only one where it was proved to be producing a functional secretion, the effect of which was modified by the removal of the growth. Surely if such is to be insisted on for every glandular tumor, the proof of their source of origin will be difficult to establish in many. The origin of the hypernephroma from adrenal rests in the kidney has been controverted on three grounds, histologic, biologic, and anatomic, the histologic being on the grounds of the marked histologic difference between carcinomata of the suprarenal cortex and renal hypernephromata.

The biologic ground is the fact, as Glynn has pointed out, that epithelial neoplasms of the suprarenal cortex as the result of the physiologic activity of these cells produce a diminution of female and the development of certain male characteristics in women before the menopause as well as precocity in children of either sex, and since this feature has never been associated with hypernephromata of the kidney the origin of the latter from accessory suprarenals is said to have been disproved. The anatomic argument is that hypernephromata have been observed to originate primarily in the medulla of the kidney, a situation in which adrenal rests have not been observed. All I would say is that as regards the first argument a resemblance exists that appears to have deceived many able observers. As regards the second, the clinical manifestation of a functional secretion is rarely present from tumor growth, and as for the third I think it is probable that an adrenal rest in this situation will still be found.

Thus as regards hypernephroma I am still a "die hard." I will acknowledge that the euphony of the word probably has made us as clinicians use it more frequently than is justified. It is a kindly expression and comforting to the patient and his relatives. We, however, will be more careful in the future and observe its use more strictly. I would quote Kettle's excellent description of the tumor:

"The naked-eye appearance of a hypernephroma is very characteristic, and renders it possible to make a diagnosis from a macroscopic examination in a high proportion of cases. In typical examples there is a primary encapsulated tumor surrounded by daughter tumors, which diminish in size as the limits of the growth are approached. Unaltered areas of tumor tissue are of a yellowish color, but the cut surface has usually a mottled, deeply hemorrhagic appearance, for the growths are exceedingly vascular, and there is nearly always an extensive extravasation of blood. Central cystic degeneration of the larger nodules may occur, but more commonly there are areas of mucoid degeneration mingled with zones of dense fibrosis, the appearance as a whole suggesting very strongly the presence of cartilage. The microscopic structure is of great interest. The tumor cells are cuboidal in shape, but they are likely to become distorted as the result of mutual pressure; sometimes they are distinctly columnar. They have a small, round, deeply staining nucleus, and are distinguished by the clear, vacuolated appearance of their cytoplasm, an appearance due partly to hydropic distention, partly to the solution, in the process of prepara-

tion, of the fat and glycogen present in the fresh state. Their arrangement is extremely variable. Trabeculæ or solid alveoli are common, and the latter may exhibit a lumen from the degeneration of the central cells. In some tumors there is a true acinous formation, and in others the cells are often disposed in a papillomatous manner around a vascularized connective tissue core. Occasionally cystic spaces, which may be partly filled up by an ingrowth of the lining cells, are formed, and every now and again the cells may be loaded with pigment granules, probably as the result of old hemorrhages. Except in the older parts of the tumor the stroma is always extremely scanty, and the groups of cells are separated by, and rest upon, delicate capillaries which consist of little more than tubes of epithelium. The vascular supply is always abundant, and the capillaries are often dilated into large sinusoids."

The clinical manifestations which it shares with certain other renal tumors are the occurrence of intermittent hematuria, attacks of mild colic accompanying the passage of clots down the ureter, the observation of pencil-like clots in the urine voided, and ultimately a palpable renal enlargement. The hypernephroma initially is a tumor essentially innocent in nature, which by its growth displaces the renal tissue and thus destroys it. Invasion of the venous system may occur and a neoplastic thrombus thus form in the renal vein. Similarly the pelvis is invaded by a highly vascular growth which bleeds readily. If, thus, when the ureteral catheter enters the renal pelvis bright blood escapes, which soon ceases to flow owing to clotting, and the pyelogram subsequently obtained shows a clearly defined area within the kidney where the drainage system has been destroyed, and the adjacent calices are distorted, drawn out and flattened, the presence of a hypernephroma may be suspected. By excretion urography the uninvolved renal parenchyma is demonstrated as possessing good functional activity.

Papillary Adenocarcinoma, with Clear Cells.—As a rule these tumors are not encapsulated. Ewing claims that from the presence of numerous cysts with gelatinous contents, gross evidence of papillary architecture and a greater tendency to invade surrounding renal tissue, these tumors can usually be distinguished by the naked eye from tumors of the adrenal rests. Clinically they closely resemble each other, and a differential diagnosis without a histologic examination is seldom possible.

Alveolar Adenocarcinoma.—These tumors clearly originate from renal tissue. In the adult they are not uncommon. In structure they resemble the renal parenchyma. They form solid tumors in which necrosis and hemorrhage are rare. They are non-encapsulated, highly malignant, and infiltrate the kidney diffusely, perforating the pelvis and capsule, invading both veins and lymphatics, and producing metastases in many organs.

Hematuria is thus with them not a characteristic feature. On pyelographic examination little deformity may be evident but by excretion urography virtually an entire absence of renal function may be revealed, no photographic evidence of the kidney or pelvis being evident.

The Mixed Tumor or Embryonal Adenomyosarcoma of Infants.—This is one of the most characteristic tumors of the kidney. It occurs frequently in infants, is of rapid growth, attaining in some cases to very great size, and ultimately proving fatal, but metastases are of exceptional occurrence. The composite structure of the tumor indicates clearly its embryonal origin, which until recently was accounted for by the inclusion within the kidney during development of tissue of extrarenal origin. As early as 1886, however, Mr. F. T. Paul, the Liverpool surgeon, expressed the opinion that this tumor was purely metanephric in origin and essentially a malformation. The tumor is usually of a solid, flesh-like consistence, and thus is often described as a sarcoma of the kidney. On section a composite structure is usually found which contains glandular, fibrous, muscular, and highly cellular tissue. Islands of cartilage are sometimes encountered, and even bone has been observed. Those who consider the tumor metanephric in origin account for the structure by metaplasia of the renal blastema. The history and clinical indications of these tumors are so characteristic as to provide in themselves a diagnosis that is usually conclusive. Pyelographic examination shows a grossly distorted renal pelvis, with obliteration of certain of the calices and elongation of others. From the fact that the tumor is sharply separated from the remnant of the organ and permeation of this by the growth does not occur, the assumption is warranted that by excretion urography indication of renal function would be evident in the uninvolved renal tissue.

THE VALUE OF A COMBINED EXAMINATION BY INFUSION AND EXCRETION UROGRAPHY IN FORMING A DIFFERENTIAL DIAGNOSIS AND PREOPERATIVE PROGNOSIS IN RENAL TUMORS

From the description that has been given on the various tumors of the kidney, it has been brought out that the renal parenchyma adjacent to the primary growth is affected in different ways. In the innocent villous papilloma of the renal pelvis it is unaffected. When the growth is of a low degree of malignancy, such as in a hypernephroma or papillary carcinoma with clear cells, the drainage system locally is destroyed and the adjacent calices are elongated, distorted and flattened, but the parenchyma remains functionally active.

In the alveolar carcinoma, on the other hand, the primary tumor may be small and the drainage system both locally and throughout the kidney little affected, although the organ is widely permeated by the malignant disease.

Clinically, therefore, the prognosis does not depend on the enlargement of the organ produced by the growth but is revealed especially by the functional activity as demonstrated by excretion urography. If therefore after injection of the dye no, or only a very faint, shadow is seen, the prognosis is correspondingly bad. In such a case the difficulties to be anticipated at the operation are involvement of the renal pedicle by dense malignant adhesions, with fixation of it to the adjacent renal lymph glands involved in the disease. Here the risk of operative treatment is greater, and the ultimate prognosis is much more serious.

When the perinephric fascia is incised at the outset of the operative treatment of a hypernephroma or papillary carcinoma, frequently a complication is at once revealed in large accessory veins coursing through the perinephric fat to the abdominal parietes. From this appearance the conclusion may be arrived at that the renal vein is blocked by a neoplastic thrombus and a collateral circulation through the capsule and perinephric fat has been established.

The difficulties in these cases are therefore twofold: the control of the collateral circulation, and the treatment of the neoplastic thrombus. To overcome the former, the wound in the abdominal parietes first of all, if necessary, should be enlarged to afford free

exposure for rapid mobilization of the kidney. If this is achieved by blunt dissection and the hand carried around the kidney in the perirenal fat, the veins of the collateral venous return will be torn and severe bleeding will ensue. On the other hand, if each vein is deliberately isolated and ligatured, the interference with the venous return which with each ligation becomes greater will lead to extreme engorgement of the kidney and venous bleeding. An intermediate course should be followed. The main collateral venous trunks may be isolated and ligatured, and then by a rapid hand dissection the kidney mobilized and the pedicle grasped and the renal artery compressed, disregarding the venous bleeding, which at this stage may be profuse. When the pedicle is grasped, a sensation is experienced which, when once felt, is easily identified again, this being due to the renal vein filled by a neoplastic thrombus. In dealing with this, the course followed will be influenced firstly by whether it is the right or the left kidney that is being excised. On the left side an attempt to remove the entire thrombus concurrent with the excision of the kidney is justified, and an effort should be made to palpate its limit within the vein. To do this, traction is exercised on the mobilized kidney, and the renal vein lightly grasped between two fingers which are pressed inwards until they are felt to slip over the end of the growth within the lumen and grasp the collapsed walls of the vein. Fortunately the neoplastic thrombus is not adherent to the walls of the channel, and thus, being mobile, the closed fingers are now withdrawn outwards and in doing so the thrombus is milked back along the vein towards the kidney. Having thus established the feasibility of this treatment, the renal artery is now ligatured and the previous maneuver having been repeated the vein is ligatured and divided.

This is the ideal operative technic in such a case, but I would not advise its adoption on the right side except in an exceptional case owing to the close proximity of the inferior vena cava. I would rather recommend as the method of election a procedure which is our second alternative when operating on the left kidney. In it, the renal artery and vein are ligatured independently, the neoplastic thrombus being divided. The kidney having been excised and the wound cleansed and a perfect exposure of the ligatured stump of the renal pedicle having been obtained, the vein is isolated and grasped and traction made on it, and the limit of the growth felt

for. If this can be made out, a procedure essentially similar to that previously adopted when the left kidney was being treated may be followed. If the limit of the thrombus cannot be felt, I would advise that the ligature on the vein be deliberately removed, and the growth withdrawn within its lumen. At first sight this might appear a somewhat dangerous procedure when dealing with the right renal vein, as in such a case the growth frequently extends into the lumen of the inferior vena cava. It is neither dangerous nor difficult if the following technic be adopted. If necessary, the wound is enlarged to provide free exposure. The inferior vena cava is exposed for several inches above and below the entrance of the right renal vein. The first assistant presses lightly on the inferior vena cava above and below with the outer borders of the little fingers of each hand, and as the blood pressure in the vein is zero, only a gentle pressure is required to control the circulation. This pressure is maintained by him until the thrombus has been extracted and the vein again ligatured.

When a very light tumor is present, as is the case frequently in embryonal carcinoma in infants, I would recommend that a lumbar, transperitoneal incision be employed. This route provides not only free acess but also protects the colon, which is likely to be damaged, as it is usually stretched over the convexity of the swelling and its blood supply courses over the anterior surface of the projection. By careful dissection the colon and the posterior parietal peritoneum and the blood vessels are mobilized and displaced inwards. In doing so, the abdominal viscera should be carefully packed off, as in more than one case I have found on the posterior surface of the bowel and between it and the kidney a small perineoplastic abscess. The kidney is subsequently excised.

We have seen that we approach the treatment of an alveolar carcinoma anticipating difficulty of removal and a bad ultimate prognosis. No undue perirenal vascularity is likely to be met. Fixation of the renal pedicle and involvement of the renal glands, however, may be encountered. On the whole I think the removal of the kidney is justified when glands which are involved cannot be excised, as I consider life is lengthened thereby. If, owing to the fixation of the kidney of an extreme degree, its excision would be both difficult and dangerous, it is preferable to leave it untouched.

There are, of course, many other problems which arise in the course of the diagnosis and treatment of tumors of the kidney. Here I need not refer to the many causes of renal enlargement and bleeding which clinically simulate new growth formation. The many diagnostic aids available virtually always suffice to establish the nature of these and to differentiate them from tumors.

Cases, however, are encountered where tumors are present in association with other diseases, as renal calculi and carcinoma, or the case may be complicated by the new growth having arisen in a kidney which is the site of a congenital abnormality.

Seven years ago there came under my care a patient, a man who had been wounded in the left loin during the war, and his medical history sheet recorded the fact that when he was then operated on a wound of a horseshoe kidney had been treated. When he came to me his complaint was persistent hematuria and a progressively increasing debility. The preliminary X-ray examination revealed a large stone in the left renal pelvis. Ureteral catheterization demonstrated that the bleeding was coming from the left kidney, and the pyelographic examination showed the renal parenchyma to be largely destroyed. On the grounds of the persistent bleeding and the progressive debility, tumor formation was suspected, and at the operation an epidermoid carcinoma was found to be present.

So far I have never been confronted with the problem of the treatment of a tumor situated in a single, functioning kidney, although I have observed two cases that had been treated by nephrectomy without adequate preliminary investigation. In one, a subsequent postmortem examination revealed that a single, functioning kidney had been removed and in the other I strongly suspected that this had taken place. Certainly the excuse pleaded by one of the surgeons that the kidney had to come out in any case would not be accepted by you. I presume the choice would lie between leaving the case to follow its natural course, a local excision of the growth, or treatment of it by inserting radium needles into it, but here in my ignorance I seek your advice and do not advise.

My theme in brief may be stated to be based essentially on the relative rôles of infusion and excretion urography. Infusion urography indicates form. Excretion urography indicates func-

tion. The former is the primary diagnostic aid for the recognition of the presence of a tumor of the kidney. The latter, by indicating the state of the adjacent renal parenchyma, is a valuable aid in identifying the type of growth that is present.

This knowledge not only permits of a more accurate pre-operative prognosis but also thereby gives warning of some of the complications that may be met. Of these the most important are: the daughter tumor concealed in the ureter in a villous papilloma of the renal pelvis; the accessory venous circulation in the perinephric fascia due to a neoplastic thrombus in the renal vein in cases of hypernephroma or papillary carcinoma; the involvement of the renal pedicle and the adjacent lymph glands in cases of alveolar carcinoma.

In other types of tumor, such as the epidermoid carcinoma and the embryonal carcinoma, and the rare tumors, information of similar value is also obtained. It amounts to this: "The degree of malignancy of a tumor of the kidney is in inverse proportion to the functional activity of the organ as a whole."

DISCUSSION

DR. J. R. LEARMONTH (Rochester, Minn.): These slides, which I showed to Dr. Kretschmer last night, have a direct bearing on his paper today. I thought you might be interested in seeing them.

(Slide) This shows the trigon after removal of the mucous membrane; with the loop of fibers from the trigon, which closes the lower ends of each ureter. Dr. Kretschmer has pointed out that where the bladder is fighting obstruction, and its muscle hypertrophies, he has found the lower end of the ureter with hypertrophy of the muscle around it.

(Slide) This shows you—and it is the only one in captivity—a direct kymograph record of the contraction of the trigon after stimulating its nerve. This is made on the kymograph in the operating room with a mercury manometer. You see the rise in intravesical pressure as a result of the contraction of the trigon itself.

DR. ARTHUR L. CHUTE (Boston): I want to express my indebtedness to Mr. Wade for bringing us his paper.

I was unfamiliar with the point Mr. Wade made: that intravenous pyelography shows so relatively badly as compared with retrograde in cases of this sort. It seems to me an important diagnostic point.

I am very much impressed by the way he goes ahead and takes thrombi out of the renal vein and cava when he finds them, in doing a nephrectomy for tumor. I hope I may have the courage to do this the next time I meet that condition. I have always felt pretty hopeless in this situation, but I think I may be stimulated to be braver now.

DR. WILLIAM F. BRAASCH (Rochester, Minn.): Our society is certainly to be congratulated upon having the privilege of hearing this very interesting paper by Mr. Henry Wade.

My experience coincides to a very large degree with that of Mr. Wade as to the value of intravenous or excretory urography in the differential diagnosis of renal tumor. I will say, however, that if we relied upon the intravenous urography entirely, we would frequently find ourselves in difficulty. It may be quite misleading.

I agree with Mr. Wade that unless a man is skilled in the diagnosis and interpretation of pyelography, he should not attempt to employ intravenous urography. Unless the details of the pelvic deformity are clearly visualized, interpretation may be frequently misleading. I have observed a number of intravenous urograms in which we might infer that we are dealing with a normal pelvis, where neoplasm was found present when the retrograde method of pyelography was employed.

Secondary infection or reflex irritation may affect the degree of visualization with intravenous urography, so that great care must be employed in its interpretation. The two methods of intravenous and retrograde urography are often very valuable when combined. Very often intravenous urography is distinctly better than the retrograde method, when there is obstruction at the ureteropelvic juncture or retention of urine in the pelvis.

The value of differentiating the different types of renal tumor is self-evident, particularly with regard to prognosis.

With hypernephroma or papillary adenocarcinoma, it is of the utmost importance to determine the degree of malignancy. Not long ago Dr. Foulds and Dr. Scholl went over the cases of hypernephroma and found a marked difference in the prognosis, depending on whether the hypernephroma cell is clear or granulated. More recently Dr. Hand reviewed our cases of papillary carcinoma and found that the prognosis conforms rather closely to the degree of malignancy of the cells of hypernephroma as graded by Broders.

We have, therefore, I think, a subject of great practical value brought before us, and I am sure we appreciate the admirable contribution made by Mr. Wade.

Dr. D. W. MacKenzie (Montreal, Canada): I want to add my congratulations and appreciation to Mr. Wade for his paper.

On the question of removing the extension of the kidney growth from the renal vein, I cannot say I would recommend it as a steady diet, but I wish to report a case in which this was done on our service. The patient was a very fleshy man with a large tumor of the right kidney. On removal of the growth we found a gland in the vicinity of the pedicle and also this thrombosed-like extension into the vein. After some little thought, we decided to open the vein and remove the thrombus. It was not difficult.

I was quite surprised how little trouble we had with it. I have not tried it since. I think I will try it again if occasion arises. As a matter of fact, this man has since passed away from cerebral hemorrhage between four and five years after his operation.

In regard to Dr. Shupe's paper, I would like to draw attention to how easily those cases of ureteral injury deceive the operator. We have seen several cases. One thing that has impressed me very much is the absence of symptoms referable to the loin following such accidents.

One of the first cases that drew my attention in this line was a woman who was operated on for a malignant growth of the uterus some years ago. She died shortly after operation. At no time did she complain of any pain in the region of the loin, but autopsy showed total occlusion with marked distention of the renal pelvis and ureters.

Following this, two years later, I was called on the fourth day to see a woman who had passed no urine following a gynecologic operation. There were no symptoms referable to the loin at all. The first day I saw her she was more or less "dopey" and even with rather crude manipulation of the loin she complained very little. The following day I relieved the obstruction by pyelotomy (bilateral). Two days later I tried to catheterize from the bladder, but failed. Four days later she voided, and is still doing so.

In these cases I venture as an explanation of the absence of pain that the patients are under a general anesthetic when operated upon and probably at the time of the beginning dilatation, when they are supposed to have the most pain, they have not recovered from their anesthesia. I am impressed by the fact that they do not complain of symptoms referable to the loin in proportion to the findings.

DR. H. L. KRETSCHMER (Chicago): In one of my patients there was no evidence of obstruction at the bladder outlet, but there was a history of a very severe diphtheria the year before. In a second case we were able to determine evidences of obstruction at the bladder outlet or in the ureter. In the rest of the patients there was definite evidence of obstruction and, as the slides indicate, definite thickening of the bladder muscle.

Some men believe that dilatations of the ureter that occur in association with benign prostatic hypertrophy are due to compres-

sion of the intramural part of the ureter because of the thickening of the bladder wall. It would seem from this study that such an explanation cannot be used in this group of cases. Evidently it is not a mere mechanical compression of the ureter by the bladder wall but an hypertrophy of the ureteral muscle.

DR. THOMAS P. SHUPE (Cleveland): Just one more point, and that is the bilateral severance of the ureters. The ability to obtain urine with ureteral catheter does not prove the ureter has not been severed.

I was very badly fooled in one case of bilateral severance, where the surgeon declared the right ureter had been cut; he was sure of that. He was equally sure that the left ureter had not been cut. The patient failed to pass any urine. A double nephrostomy was done, and later, when she was able to move to the cystoscopic room, we found complete obstruction about 4 centimeters from the bladder on the right side, and on the left side an obstruction I think at about 3 centimeters.

After considerable manipulation, I got the catheter through and put it up 70 centimeters, and then began to drain urine and left the catheter in. It drained urine for forty-eight hours or more, and then subsided. There was no more.

The patient developed a urinary abscess in the left loin, which was opened extraperitoneally, and the diagnosis was severance of the right ureter with fistula of the left ureter in the lower portion.

We decided to repair the fistula of the left ureter. We found it all right, inserted a catheter down into the bladder and up toward the kidney, and expected to pick the catheter out of the bladder later.

No urine drained from this catheter. An X-ray showed my catheter (illustrating on the blackboard) like that. There was a fistula in the ureter, but it was severed down there.

I had been draining the pocket of urine, 6 centimeters from the bladder, and when I put my catheter in here I closed up this part. In that case later transplantion was necessary.

MR. HENRY WADE (Edinburgh, Scotland): I would say just a word on the rôle of intravenous urography. A certain percentage of the patients are going to competent men, but a fairly large percentage are going to the care of the young enthusiastic surgeons

in the small hospitals, under the care of brilliant young men but not completely trained men. These men are turning to intravenous urography as a means of diagnosis of renal disease. What we are trying to do with these fellows is to tell them that is wrong, that they will never find out the morbid anatomy or the contour of the disease by that urography. A great advance will be made thereby.

MODERN ASPECTS OF THE SURGICAL TREATMENT OF UROGENITAL TUBERCULOSIS

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The past few years have witnessed a changing attitude on the part of the medical profession concerning the surgical treatment of tuberculosis of the urogenital system.[1] This has come about as the result of careful clinical studies of the earlier stages of urogenital tuberculosis and the use of this information in the medical and surgical treatment. The pathologic and experimental aspects of the earlier lesions have been thoroughly studied by Medlar and Medlar and Sasano, whose reports were published in 1924,[4] 1926[2] and 1932.[3] In previous communications[5] we presented the results of clinical studies of large numbers of tuberculous individuals in whom we attempted to discover early lesions of renal tuberculosis and to evaluate these findings in the light of all available experimental and pathologic data. In these communications we called attention to the following: First, tuberculosis is a constitutional disease, urogenital infection being only a local manifestation. Second, renal tuberculosis is practically always hematogenous in origin and may be primarily a bilateral implantation. Third, lesions of tuberculosis in the kidney may be destructive or inflammatory; the inflammatory lesions may heal. Fourth, tubercle bacilli may not be found at all times in the urine of patients with renal tuberculosis. Fifth, tubercle bacilli in the ureteral catheterized urine from the kidney pelvis denotes renal tuberculosis. Sixth, a normal kidney can not eliminate tubercle bacilli so that excretory bacilluria may not occur. The following report is an attempt to crystallize further the available data concerning the surgical treatment of urogenital tuberculosis.

PATHOLOGIC ANATOMY OF THE INVASION AND EARLY LESION OF TUBERCULOSIS IN THE KIDNEY

Renal tuberculosis develops because of a previous hematogenous

implantation of tubercle bacilli into renal tissue. We have learned to recognize pathologically, anatomically, and by pyelograms, two types of lesions of tuberculosis in the kidney. One may be inflammatory, non-destructive, or slightly destructive. These are not visualized on the pyelogram. The other, a later stage of the former, becomes an ulcerative or more destructive lesion, which may never heal. These lesions, depending on their size and location, produce various sized filling defects in the pyelogram. They may be divided into ulcerative, which occurs at the tip of a pyramid; parenchymal abscess, the most common lesion, and tuberculous pyonephrosis. Medlar found, after sectioning entire kidneys, that lesions occur more frequently in one zone than in another. He concluded that the site and the size of arterial emboli apparently determine the type of lesion which will result. According to this work, the most frequent site of implantation, and, therefore, the most common lesion, is in the cortical zone of the kidney. This lesion begins in a glomerulus[12] or tubular capillary, where the emboli, of necessity, must be small, and here abscess formation is almost unknown. These are usually discrete lesions that tend to encapsulate and fibrose, but they may coalesce. They do not involve the medulla and infrequently produce tubercle bacilli in the urine, unless extensive necrosis occurs. The next most frequent site is in the corticomedullary, or intermediate zone of the kidney, where the blood vessels and emboli are somewhat larger and where necrosis with bacilli in the tubules and in the urine occurs frequently. These lesions start in the region of the arcuate arteries, are usually fan-shaped, and have a tendency to coalesce. They spread by way of the tubules and produce the most extensive destruction. The least frequent site of implantation is in the true medullary zone of the kidney, where subsequent abscess formation is relatively frequent. These lesions start in the pyramidal vessels, or are an infection through a tubule from a destructive cortical lesion. Clinically, we feel that the size and site of infected emboli, plus the constitutional resistance of the patient, must, to a considerable degree, determine whether a given patient will develop an inflammatory non-destructive or destructive type of lesion. If we accept the hematogenous origin of renal tuberculosis, then there certainly must be some determining factor, or factors, such as we have just mentioned, to account for the apparent discrepancy in the incidence of bilateral involvement

in the early and late types of lesions. In published reports 70 per cent of all patients seeking relief from cystitis and an extensive destructive type of renal tuberculosis have a unilateral renal lesion, while 30 per cent have bilateral lesions. We doubt the accuracy of these reports because not infrequently the diagnosis is made after only one urologic examination. Sixty-five per cent of our carefully studied series of tuberculous individuals presenting the earlier lesions of renal tuberculosis have bilateral involvement. Incomplete diagnoses, marked difference in the age of the two types of lesions and the possibility that frequent complete healing occurs with the early slightly destructive or non-destructive ones, may explain the numerical difference in bilateral involvement noted. In our opinion excretory bacilluria does not occur; *i.e.*, the normal kidney does not pass tubercle bacilli without the development of lesions of tuberculosis. Involvement of the second kidney in bilateral renal tuberculosis need not be explained by an elaborate process of retrograde extension up the ureter. It is better explained by the subsequent development of a hematogenous lesion, or lesions already present in the second kidney, or from repeated showers of infected emboli having their origin in a focus in the chest.

DIAGNOSIS OF RENAL TUBERCULOSIS

A *genito-urinary history* in the diagnosis of the early lesions of renal tuberculosis is of little value. The majority of our patients give no history of complaints referable to the urinary or the genital tract. A history that suggests that tubercle bacilli may have entered the blood stream from some lesion in the chest signifies that the kidneys may be infected, or may have been infected. A history of a previous tuberculosis is significant.

Symptoms.—Textbook descriptions and statements appearing in published articles, of the first symptoms of early renal tuberculosis, are erroneous. Frequent, painful, burning urination with pus in the urine are in fact symptoms of cystitis, a secondary and frequently late complication of renal tuberculosis. Hematuria, which would imediately lead one to suspect the kidney, has occurred infrequently with the early lesions. In the majority of early cases a diagnosis of renal tuberculosis is made before symptoms have developed that signify bladder involvement.

Experience gained from the physical examination of normal in-

dividuals has revealed that the early lesions of pulmonary tuberculosis are found in the patient who has no symptoms. This is applicable in the diagnosis of renal tuberculosis so that we begin the search for early renal lesions in patients who have no urinary symptoms. Every physician and surgeon interested in the diagnosis and treatment of tuberculosis should realize that lesions may develop insidiously in the kidney.

Urologic Survey.—Repeated complete urologic examinations is the best method of determining the presence or absence of ulcerative or destructive lesions of tuberculosis in one or both kidneys. They will determine when surgical treatment is indicated or contraindicated. In our opinion insufficient data obtained during one urologic examination are the cause of the high mortality following nephrectomy. This mortality is noted during the first two years after operation and suggests that many patients are operated on when an undiscovered lesion is present in the second kidney and before the surgeon is sure that the patient has sufficient defense against tuberculosis. The chief reason why more bilateral lesions are not discovered is because the patient is not repeatedly examined. Every patient who has had tuberculosis in any form and who has cellular elements in his catheterized urine should be subjected to repeated urologic study, providing his general condition will permit. A combined phenolsulphonphthalein functional test and complete blood chemistry studies should be made before cystoscopy is undertaken. Roentgen-ray examination of the entire urinary tract, which is a routine procedure before cystoscopy, has not been helpful in the diagnosis of the early renal lesions of tuberculosis. An old pyonephrosis, or a large destructive lesion which has practically destroyed the kidney, may contain enough lime so that a mottled shadow typical of renal tuberculosis may be obtained. This is not found with the early lesions.

Cystoscopy must be carefully done and the data obtained properly interpreted. Reflux or contamination of the ureteral catheter has been assigned as the cause of the large number of bilateral lesions which we report. Reflux has occurred in 11.5 per cent of all the patients whom we have examined cystoscopically. In a previous paper we called attention to the very careful technic of cystoscopy and ureteral catheterization which we practice. We advised flushing the ureteral catheters with sterile water during

their passage through the cystoscope, the bladder and the ureter, together with a test for reflux. This in brief is done by over-distention of the bladder with methyl blue solution after the passage of ureteral catheters, and before the ureteral specimens of urine are collected. If an incompetent ureterovesical valve is present methyl blue will pass up the ureter and return through the ureteral catheter. When this occurs it is evident that the specimen is contaminated. This technic should eliminate to a great extent the possibility of contamination of urine specimens or their incorrect interpretation.

Laboratory Data.—During cystoscopy large specimens of urine should be obtained from each renal pelvis. A smear of the sediment should be examined after staining by the Ziehl Neelsen method. If no tubercle bacilli are found the sediment is injected into guinea pigs. The technic of the guinea pig test as we use it has been previously reported. Failure to find tubercle bacilli in smears of urinary sediment from catheterized specimens does not rule out tuberculosis. Tubercle bacilli may be present in only one of fifty slides examined. The injection of the sediment into guinea pigs, or culture, are more accurate tests, but here, negative findings do not necessarily mean that no lesion of tuberculosis is present. We know from experience that the excretion of tubercle bacilli into the urine from a parenchymal abscess is frequently intermittent. In a paper previously published we drew attention to the necessity of the injection of sediments obtained from several weekly specimens of urine, two of which were from twenty-four hour collections, into the same animal so that we might find tubercle bacilli when present in small numbers.

Functional Tests.—Indigo carmine and phenolsulphonphthalein are of little value in making a diagnosis of the early lesions of renal tuberculosis. When much destruction has occurred from a tuberculous pyonephrosis there may be a definite lessening of the function.

Urography.—We have been criticized because we make repeated bilateral pyelo-ureterograms with renal tuberculosis. We have made hundreds of pyelograms without observing the spread of tuberculosis into or from the kidney. We have not observed miliary infection or meningitis following, or as the result of, retrograde

pyelography. However, this examination should be done very carefully. We try to insert the ureteral catheters so that the eyes are within the renal pelvis and not in a calix tip or low in the ureter. This encourages complete drainage of the pelves so that after a measured amount of sodium iodide is injected, all of it may be withdrawn by syringe immediately after the film is exposed. Two syringes are always used, a method which prevents contamination from one kidney to the other and facilitates easy injection. We know of no method of examination that will reveal the presence of tiny macroscopic ulcerative or destructive lesions of the kidney as constantly as the pyelogram. By this method we have been able to find small ulcerative lesions and parenchymal abscesses when a specimen of urine obtained from the same kidney did not contain tubercle bacilli. Repeated bilateral pyelo-ureterograms are necessary because if only one kidney is examined, the surgeon may overlook an unsuspected lesion in the other. The pyelogram has helped to estimate the relative amount of local defense against tuberculosis manifested by the kidney. Repeated pyelographic examination of destructive lesions has taught us that the kidney may develop a local resistance or defense mechanism of considerable degree. If a patient has a good local and general resistance, a destructive tuberculous lesion of the kidney may be held in abeyance or progress slowly. When the local defense and the constitutional resistance are slight, the kidney may be quickly destroyed. These changes may be accurately followed by pyelography only. There is plenty of time available for careful study of the patient's urinary tract before surgical treatment is undertaken. Except for hemorrhage and an obstructed ureter with pain and toxemia, surgical treatment in renal tuberculosis is never an emergency procedure. Repeated pyelograms reveal that a patient may have a destructive renal lesion of tuberculosis for months, and years, without demonstrable symptoms.

In our clinic the intravenous method of urography has not been particularly valuable. It does not visualize the minor filling defects which may be observed with the retrograde method. This method is useful when it is impossible to cystoscope a patient, or to catheterize both ureters because of an obstruction or stricture. In these instances pyelography would be impossible without the intravenous method.

LOCAL AND GENERAL DEFENSE MECHANISM AGAINST TUBERCULOSIS

Before deciding upon surgical treatment for destructive unilateral renal tuberculosis the patient's general condition and his resistance to lesions of tuberculosis must be considered. Tuberculous individuals receive constitutional treatment so that they may develop resistance against tuberculosis and thus control their infection. For this reason every patient should have manifested his ability to control this disease before surgical treatment is advised. Although we have never been able to prove that a macroscopic destructive renal lesion of tuberculosis heals completely, we have much pyelographic evidence that the development of a very definite local defense may occur. We have observed destructive lesions that did not progress over a period of years. Many specimens examined after nephrectomy contain lesions of tuberculosis that are completely walled off from the rest of the kidney. In many of these we had great difficulty finding other areas of tuberculosis in the good portions of the kidney. The question of resistance against tuberculous infection and the arrest and possible cure of some lesions should be carefully considered before a kidney with a small destructive lesion that does not progress is removed, as much good kidney tissue may be unnecessarily sacrificed.

SURGICAL TREATMENT IN GENERAL TUBERCULOSIS

Among physicians and surgeons there is a lack of understanding regarding the rôle of surgical treatment in the cure and the arrest of all forms of general tuberculosis. For many years tuberculous patients, particularly those with pulmonary disease, were considered unsuitable subjects for surgical intervention. Many patients, so handicapped, remained unaided because they were denied the benefits of surgical treatment. Today this attitude has been somewhat modified so that we frequently encounter evidences of overenthusiasm with instances of ill-advised and injudicious use of surgical treatment in this field. The greater one's knowledge of the destructive effect of lesions of tuberculosis, the greater becomes one's respect for its potential possibilities for doing harm. Likewise, the more the physician or surgeon knows about a given individual's resistance against this disease the more intelligently he may be able to plan and direct the surgical treatment.

A rather conservative attitude toward surgical treatment in the

tuberculous individual may be briefly summarized as follows: Tuberculosis is primarily a constitutional disease with local manifestations in various organs. It is rarely possible to extirpate all of a given individual's tuberculosis, so that in general it may be stated that surgical treatment does not cure but is an aid in obtaining a clinical result.

Recent or acute pulmonary tuberculosis with the exudative types of lesions presents a very treacherous field for surgical attack, if attempted before the patient has mobilized his powers of resistance. Radical surgical treatment at this time may not benefit the patient but may be the direct cause of a marked exacerbation of the disease which leaves him far worse than before surgical treatment was instituted. The chronic fibrotic stages of the disease offer a safer field for surgical intervention, but here, as well as during the acute stages, the surgeon must recognize that any trauma which greatly lowers the patient's local or general resistance may be followed by a lighting up of an apparently quiescent tuberculous lesion, either locally or in some distant organ. The careful selection of patients, as well as the time of operation, is of paramount importance if surgical treatment is to be undertaken. A very careful surgical technic, which includes gentleness in handling of tissues, the avoidance of shock and unnecessary trauma and careful pre-operative and post-operative treatment, is imperative. The avoidance of anesthetic trauma to the lungs by inhalation anesthesia is necessary because this may re-activate quiescent pulmonary disease. Surgical trauma may be a causative factor in the metastasis of tuberculosis to various portions of the body. Tuberculosis rarely presents indications for emergency operations, so that plenty of time may be taken for complete diagnosis and for the arrangement of conditions most favorable to the patient contemplating surgical treatment. It is a well recognized fact that tuberculous individuals recover from all illnesses and surgical treatment more slowly than others. Postoperatively, therefore, they must be given sufficient time to make complete recovery from their surgical treatment, so that any residual infection or any lesions activated by the surgical manipulations may become quiescent. It is evident that tuberculous individuals require more careful management than average individuals. However, if their special problems are recognized and evaluated, it is surprising how much surgical treatment has to offer

them. Many of the surgical principles which apply in the treatment of pulmonary and general tuberculosis are applicable in the surgical treatment of urogenital lesions.

TREATMENT FOR UNILATERAL DESTRUCTIVE RENAL TUBERCULOSIS AND THE TECHNIC OF NEPHRECTOMY

Unilateral extensive destructive lesions of renal tuberculosis require nephrectomy, but only at a time when the operation may be done with the least danger to the patient. Unilateral and bilateral non-destructive lesions of renal tuberculosis are medical conditions and should have intensive medical treatment. Unilateral, slightly destructive renal tuberculosis should be treated conservatively under careful observation. Nephrectomy is indicated only when progressive disease is present.

Anesthetic.—We use spinal anesthesia whenever it is possible, as it produces no lung irritation, less trauma to the tissues during removal of the kidney, better exposure is obtained, and the operation may be completed rapidly.

The fat surrounding the kidney and as much of the ureter as possible is removed. The ureter is incised with an endotherm knife, tied, and the remaining stump injected with pure carbolic acid. The carbolic acid sterilizes the ureter so that it may not become a factor in subsequent infection of the wound, in the production of a sinus, or in continuing infection of the bladder. When the ureter is obviously infected or dilated a hollow tube gutta-percha drain is slipped around the cut end of the distal stump where it is held by a chromic gut ligature. This is allowed to remain for at least three weeks. If the ureter is not infected no drain is used. When the ureter is being treated, we are very careful to protect the surrounding tissue from contamination. The end of the ureteral stump attached to the kidney is covered with a small piece of hollow tube drain, so that contamination of the wound may not occur from this source. Drainage of the kidney fossa or the incision is unnecessary.

Close, accurate approximation of the several tissues of the wound should be made with care. Figure-of-eight braided silk tension sutures embracing all tissue layers, including the fascia and skin, tied over large pearl buttons, have been comfortable and satisfactory. These sutures tied in bow knots so that they may be adjusted at will may be left in the wound for six to eight weeks.

Re-opening of the incision following nephrectomy for renal tuberculosis occurs in the patient who has little or no resistance, and is the result of perinephritic involvement at the time of operation, contamination of the incision by an accidentally opened ureter or kidney pelvis, rupture of an abscess, or, rarely, from a residual tuberculous ureter. If the patient has sufficient resistance, many of these factors will not become operative, so that the wound will heal completely and permanently.

Chronic sinuses that may develop following removal of a tuberculous kidney are excised with the endotherm knife so that complete exposure of all ramifications is attained. Every portion of the wound surface is then thoroughly destroyed with bi-polar diathermy. Following this, the wound is packed with sterile gauze without suturing and is repacked and treated with actinic light daily. Aseptic precautions must prevail during the daily dressing of these wounds if secondary infection is to be prevented. If the patient has good resistance against tuberculosis, the wound and sinuses will heal promptly from below upward.

THE TREATMENT OF BILATERAL LESIONS OF RENAL TUBERCULOSIS

As mentioned previously in this paper, we find clinically that 65 per cent of the early lesions of renal tuberculosis are bilateral. Patients may have a macroscopic destructive lesion in one kidney, and a non-destructive or slightly destructive lesion in the other. These kidneys should be re-examined repeatedly and frequent urinalyses and pyelograms should be made to estimate the progress of the macroscopic destructive lesions in one kidney, and to search the other for evidence of the development of macroscopic destructive lesions. We have watched patients apparently heal a non-destructive lesion in one kidney, so that we were able subsequently to remove the other kidney containing the destructive lesion. We have observed some patients with bilateral infection develop enough defense mechanism, during constitutional treatment, so that the lesions in their kidneys did not progress, and their bladder symptoms practically disappeared. A number of our bilateral group of patients have returned to work for several years. A patient with bilateral renal tuberculosis, in our opinion, is not a hopeless case. His span of life from the genito-urinary standpoint is measured by the available functioning renal tissue present. He must remain under con-

stitutional treatment in a sanatorium until a thorough defense mechanism is built up, so that lesions in his kidneys and any extra-urinary activity may be controlled. Bilateral renal tuberculosis is usually not a surgical condition. Almost every tuberculous kidney contains some good tissue so that two tuberculous kidneys contain more reserve tissue than one. Occasionally, nephrectomy may be justified when a patient with bilateral destructive lesions has severe pain, hemorrhage, or obstruction of the ureter.

SURGICAL TREATMENT FOR TUBERCULOSIS OF THE LOWER URINARY TRACT

Tuberculosis in the scrotum is usually an infection in the epididymis and vas deferens and not in the testicle. Seventy-five per cent become bilateral. In only an occasional instance we are unable to find clinical evidence of tuberculosis in the prostate with infection in the epididymis. During the past five years, we have been interested in the association of lesions of tuberculosis of the lower urinary tract and the kidney. In only one patient of the last thirty-five were we unable to demonstrate the presence of a lesion in the kidney when tuberculosis of the epididymis was present. This occurred in a man who was discharged from the sanatorium as an arrested case before we were able to re-examine him completely. William M. Spitzer[5] in a recent article states that tuberculosis of the genital tract is probably due in the majority of cases to extension from the upper urinary tract.

Tuberculosis of the epididymis may be a very acute condition, progressing frequently to abscess formation. These abscesses may be aspirated, or drained externally so that the acute process will subside, after which an epididymectomy may be done. Many patients who have had epididymal abscesses drained, plus heliotherapy and constitutional treatment, have recovered completely. When operative treatment is indicated, epididymectomy should be done and not castration. The epididymis, together with the vas up to the internal ring, may be carefully resected without destroying the blood supply to the testicle, or the testicle itself.

We have noted during our complete urologic examinations and in our autopsy material that tuberculosis of the prostate progresses to abscess formation frequently. These abscesses drain into the urethra and may be the cause of producing pus or tubercle bacilli

in the terminal urine. With the cystoscope, large dilated infected prostatic ducts and abscess cavities may be seen. Associated with abscess of the prostate we have encountered extensive ulceration of the bladder, out of proportion to the renal lesions present.

CONSTITUTIONAL TREATMENT OF UROGENITAL TUBERCULOSIS

The constitutional treatment of tuberculosis, *i.e.*, rest and heliotherapy, should be given both before and after surgical treatment. This enables the patient to arrest any residual infection by keeping up his resistance. In the sanatorium, any patient who submits to any type of surgical treatment is required to remain in bed, at rest, with heliotherapy when possible, from one to six months following operation. This is a good rule for patients who are not residents of a sanatorium, but it may be varied according to the patient's manifested resistance, his temperature, and general condition after the operation. Every patient with urogenital tuberculosis should know that he is suffering from a general disease, and that the removal of his kidney alone may not cure him. He should be told that the cure of tuberculosis is achieved only by the patient himself, and requires time and patience. In the management of urogenital tuberculosis, treatment should be directed at the patient as a whole, not the local lesion alone. Bed rest and heliotherapy after operation apply particularly to the patient who has remaining lesions of tuberculosis, such as cystitis. We have observed many patients with very severe tuberculous infections of the bladder return to normal during careful hygienic treatment.

CONCLUSIONS

1. The successful surgical treatment of urogenital tuberculosis depends primarily upon an accurate diagnosis. This may be accomplished only after repeated complete urological examinations.
2. Surgical treatment for any type of tuberculosis, except in an emergency, should not be undertaken until the patient has developed a sufficient defense mechanism.
3. Surgical treatment of urogenital tuberculosis is rarely an emergency.
4. Surgical or medical treatment of tuberculosis should aim at the patient as a whole, not alone at the local lesion.

5. Renal tuberculosis or other urogenital lesions are local manifestations of a constitutional disease.

6. Non-destructive renal tuberculosis, unilateral or bilateral, is a non-surgical condition and should be treated intensively by medical methods.

7. Tubercle bacilli in one specimen of urine obtained from the kidney pelvis is not in itself an indication for nephrectomy.

8. Unilateral slightly destructive tuberculosis should be treated conservatively under careful observation. Nephrectomy is indicated only when progressive disease is present.

9. Extensive unilateral destructive lesions should be treated by surgical methods.

10. Bilateral destructive renal tuberculosis is not a surgical condition except to stop hemorrhage or to relieve pain and sepsis, the result of an obstructed ureter.

11. This condition is not always a hopeless one as ordinarily considered. Under careful medical management it may be compatible with life and useful work for a number of years.

12. Genital tuberculosis is usually an infection of the prostate and epididymis and in a high percentage of patients is associated with a renal lesion.

13. Tuberculous abscesses of the prostate occur frequently. They drain into the posterior urethra and may produce pus and tubercle bacilli in the urine.

14. Tuberculosis of the epididymis is often an acute disease and may be cured by drainage and heliotherapy. When an operation is necessary it should be epididymectomy and not orchidectomy.

15. Surgical treatment of tuberculosis does not cure the disease but is merely a mechanical aid in producing a clinical result.

16. Constitutional treatment of urogenital tuberculosis is important and should supplement the surgical treatment, both before and after operation.

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THE ORIGIN AND RÔLE OF URINARY PROTEINS

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The kidney has long been regarded as an organ of excretion, but until recently the limitations of its ability to excrete have not been recognized or defined. The truth is that the normal kidney can excrete only those substances which are released or unbound for it by the body tissues, and that its activity toward water, minerals, and metabolites is determined, like a conditioned reflex, by the state of the tissues. This is most clearly understood in relation to water excretion and edema. We all know now that edema is not due to inability of a kidney to excrete water, but to a primary tissue thirst or, chemically speaking, a hydrophilic state of colloids, which attract and hold water from all sources, including the blood, with a consequent anuria and edema. This tissue avidity is best demonstrated by Aldrich's skin absorption test, in which an intradermal injection of physiologic salt solution is slowly absorbed from normal skin, requiring forty or more minutes, while in states of edema it is very rapidly absorbed—the greater the edema, the more rapid the absorption. When, however, due to improved metabolism, the tissue health improves, its thirst or affinity for water decreases, water is released into the intercellular spaces, passes to the circulation, and is promptly excreted—all this without any change in the kidney itself.

The foregoing proposition is only one of many problems arising with our recent extensive revision of theories regarding nephritis. This change briefly is as follows: Formerly we believed that the kidneys, as the result of inflammatory or degenerative changes, became incapable of excreting water, soluble minerals and metabolites, and of retaining within the circulation the proteins of the blood, and that the clinical aspects of nephritis were due to the action of these retained substances. The revision of this point of view is not within the sphere of this paper, but while engaged in investigations pertinent to this problem, I was confronted with the task of explaining a renal lesion that did not permit the excretion of water, minerals of small atomic weight, and metabolites, such

as urea, but which freely permitted the enormous aggregates of serum protein (albumin and globulin) to pass. Consequently, I evolved the theory, subsequently verified, that the kidneys, either normal or diseased, possessed a vital and selective activity toward protein that allows them to excrete all foreign protein, that is, proteins not normal to the circulation of that individual or animal, while retaining those proteins which belong in the blood stream. Thus blood or serum from another species, or protein from a foreign source, such as egg, will be promptly excreted, and, I wish to emphasize, even when the kidney is diseased.

In seeking assistance in determining the degree of change a blood protein must undergo, I enlisted the aid of Dr. Welker, at the University of Illinois, who has mastered to a great degree these substances. Finding there was no structural or chemical method of determining these factors, we employed Dr. Hektoen's precipitin test, with final success.

Andrews and I found that typical and satisfactory nephritis and uremia were produced in dogs by the intravenous injection of a 5 per cent solution of sodium chloride, and the urinary proteins were studied. Post-mortem examination of dogs in which severe uremia was produced revealed a marked breaking down of liver tissue with a decrease in calcium and a marked increase in sodium in the liver and we felt that some of the protein in the urine was derived from this source. Identification of proteins can be made only by immunologic methods. With the advice of Dr. Hektoen we prepared a potent precipitin, using liver extract—our anti-dog liver precipitin. The protein excreted during the first hours of artificial uremia in dogs reacted strongly to our anti-liver precipitin, but not at all to an equally potent anti-dog serum precipitin, indicating the presence of liver tissue without serum proteins in the urine. Gradually, however, the liver reaction became weaker and the serum reaction stronger, the liver protein being finally masked altogether. Later, with the same method, we identified central nervous system, muscle and spleen protein in these first fractions of urine.

Using the later portions of urine, showing only serum protein, Dr. Welker succeeded in identifying a toxic peptone radical attached to the protein molecules, giving proof of the principal point in our theory of urinary proteins, since the combined peptone-serum protein radical, was a foreign protein.

The excretion of serum proteins (albumin, pseudoglobulin and euglobulin) in nephritis, orthostatic albuminuria and allied conditions indicates that these proteins have become so altered that they no longer conform to the requirements of the particular organism and are therefore treated as foreign. This process, however, is not confined to the renal capillaries but to every capillary in the body. The marked loss of serum protein in nephritis, falling often to 50 per cent of the normal content, is due to the constant loss through the capillaries throughout the body as well as the renal loss, which may be quite small.

In an artificial nephritis, then, by the simple introduction of sodium chloride into the body there occurs a rapid and marked reallocation of minerals, calcium leaving the tissues, reaching the blood and being excreted, while sodium replaces the calcium in the tissues, notably the liver and the central nervous system. As a result, the vital electrolytic equilibrium is destroyed, cell membranes are broken, cellular integrity is lost, and tissue (liver) protein as such is released, first in the intercellular spaces, passing shortly into the circulation (unaltered), excreted as a foreign protein and identified as such in the urine. It is a relatively normal non-toxic tissue protein, retaining its immunologic identity but not belonging in the blood. Shortly, as the process proceeds the cells are further damaged, the protein is split so as to lose its identity, and as this splitting is carried to the proteose-peptone stage the split products become highly toxic. At this point, then, they unite in the blood stream, with a normal molecule of serum protein. The two combined form a foreign protein and are excreted, though the combination retains its identity by the precipitin test.

To prove the theory of the specific, selective action of the kidneys with regard to normal and foreign proteins, the liver of a normal dog is rapidly ground in a ball mill under conditions preventing protein alteration, extracted with physiologic solution of sodium chloride, and the extract injected intravenously in a normal dog. The extract contains liver tissue and normal blood. There promptly appears in the urine a protein identified as liver, with no blood appearing. This liver protein is antigenic and may be used to prepare a pure, high titer and anti-liver precipitin.

With regard to the peptone and detoxifying function of serum protein, we succeeded in hydrolyzing the combined peptone-serum

protein radical and in obtaining each in pure form. The serum protein, when injected into a normal dog, remains in the circulation. The toxic radical, when injected, appears promptly in the urine in combination with a previously normal serum protein molecule. Further work in the process of completion by Dr. Welker indicates that other foreign proteins, notably Bence-Jones, are eliminated by the kidneys in a firm combination with normal serum albumin, while studies of mine show that the albuminurias and proteinurias of a functional type, such as orthostatic albuminuria, and the "leaky kidney" described by the British, are due to a metabolic failure of the body to build a complete, stable, or specific protein, either serum or tissue, from the primary (amino acid) material available for this purpose.

NON-PARASITIC CHYLURIA

REPORT OF A CASE OF BLADDER ORIGIN

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The frequency of non-parasitic chyluria is insufficiently established, the method of entrance, and the source of the chyle in the urine are so questionable in many reported cases, that we feel every such occurrence should be recorded. Filiariasis was discussed before this society by W. M. Mastin,[24] in 1888, and by Dr. John H. Cunningham, Jr., in 1907.[5] However, we find no reference to non-parasitic chyluria in the Transactions of this society, hence our excuse for calling attention to the subject at this time.

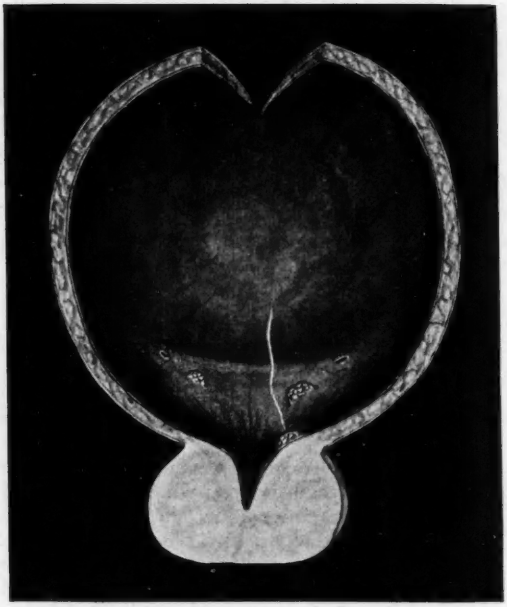
CASE REPORT

J. H., a colored man, nineteen years old, native of Indiana and never having been out of the state, came in July, 1929, complaining of painful, swollen testicles, pain in the bladder, frequent urination and the passage of milky colored urine which recently had become blood tinged.

In 1919, when nine years of age, he began, without apparent cause, to pass milky urine. Other than the pain which accompanied the occasional passage of clots from the bladder, he had experienced no ill effects from this disease. In December, 1928, he contracted gonorrhea which soon became posterior and was complicated by bilateral epididymitis. The pain from this latter condition and the urinary frequency with terminal hematuria caused him to seek admission to the hospital. During his acute gonorrheal infection his appetite was poor, and there was a gradual, progressive loss in weight. He entered the hospital in a generally debilitated condition and with a temperature of 103.5° F. There was no history of tuberculous contact.

Physical examination was negative except for the inflamed epididymi which suppurated and were drained. The sinuses subsequently healed without difficulty. With the subsidence of his venereal infection study was made of the unusual urine. It was milky white in color; alkaline; 1.018 specific gravity; sugar negative; albumin always present. The microscope disclosed numerous small fat globules, best identified with an oil immersion lens. There was no blood in the urine one month after entering the hospital. There was an occasional pus cell with

moderate urate and triple phosphate crystals. Repeated search failed to disclose microfilariæ of Bancroft. The urine was negative by stain for gonococci and negative by stain and animal inoculation for tubercle bacilli. The prostate was normal in size, not tender, free of nodules or indurated areas and the base of the bladder appeared normal to the examining finger in the rectum. A catheter passed easily and there was no bladder residual urine.



The phthalein output was 45 per cent for the first hour and 15 per cent for the second hour, a total of 60 per cent for two hours.

Following the cure of his epididymal infection the blood count was normal and remained so, and at no time was there an eosinophilia. Hourly examinations of the blood on several nights failed to disclose any microfilariæ of Bancroft. The blood and spinal fluid Wassermanns were negative and the blood non-protein nitrogen was 27 mg. per 100 c.c. of blood.

The complement fixation test for tuberculosis showed 3 plus for 0.1 c.c. and 4 plus for 0.2 c.c.

There was a chronic pulmonary infection. X-ray showed marked

bronchial exaggeration of each upper lobe where the trunk markings could be traced to the surface. There was little cough or expectoration and repeated stains for tuberculosis were negative. X-ray of the urinary tract was negative for calculus and the bony structures of the spine and pelvis appeared normal.

On July 23, 1929, at cystoscopy Dr. R. L. Smith noted that the left side of the vesical orifice was nodular and uneven and that from some point about the vesical orifice a milky fluid, the chyle, was seen to exude and coil up in the bladder. Two weeks later, at a second cystoscopy, Dr. Smith secured normal urine free of chyle from each kidney.

The patient came under the writers' observation September 1, 1929. The temperature was normal. Physical examination was negative except for well healed scars on both sides of the scrotum, each epididymis still being larger than normal. The patient had been in bed during the preceding two months and his state of nutrition was fair. He was gaining in weight and in strength. Since his admission to the hospital his urine, while it had varied in degree, had been constantly milky.

Changes in the position or in the posture of the patient did not influence the chyluria, and while variations in the amount of fat intake did influence the amount of chyle present in the urine, strictest fat-free diet for three days did not cause its disappearance. At times the patient would pass large clotted masses from the bladder. If there were no clots in the bladder almost invariably there soon would be a clot form in the voided urine which showed a tendency to become redissolved upon further standing. Unfortunately there was no complete study made of the amount of fat, fibrin or albumin in the blood or urine. The diagnosis was made from the appearance of the urine, the presence of fat globules, and a tendency of the urine to clot.

At cystoscopy September 14, 1929, there was noted some rigidity of the posterior urethra with no elevation or contracture of the vesical orifice. The posterior urethra was smooth. The bladder walls were moderately congested and inflamed, more marked about the base and trigone. The bladder capacity was good and the bladder medium was milky. Situated just below the right ureteral orifice, and below and median to the left ureteral orifice, and on the floor of the vesical orifice to the left of the median line were three lesions, exactly similar except in size. They were apparently multilobular masses with a corrugated, wrinkled surface, pearly white in color with a slightly red base. These projected into the bladder cavity for apparently 5 mm. They were not cystic and they did not collapse upon pressure. A milky fluid was seen coming from the nodule on the floor of the vesical orifice. The opening, judging from the size of the milky jet, was small and apparently on the vesical side of the nodule. No chyle was detected coming from either remaining nodule at this time. Urine free of

chyle was secured from the right kidney and the right pyelogram was normal.

One week later a second cystoscopy showed the same findings, excepting no chyle was seen to enter the bladder at this time. Clear, chyle-free urine was secured from the left kidney and a normal left pyelogram was made.

Cystograms made in the right and left oblique and lateral positions did not show the iodide solution in any channels beyond the bladder cavity.

At subsequent cystoscopies chyle was seen coming from each of the three nodules, but it was never observed issuing from any two at the same time. The chyle always entered the bladder in an irregularly, intermittent manner, and it was not influenced by movement of the body nor did it bear any relation to respiration or the pulse.

Attempts to get satisfactory photographs through the photographic cystoscope of an emission of chyle into the bladder were failures.

On October 26, November 2 and November 9, 1929, the nodules about the vesical orifice, the right ureteral meatus and the left ureteral meatus respectively, were fulgurated until each mass was seemingly destroyed. For four days following the last fulguration the urine was clear to the eye, during which period the patient felt badly and had fever, which symptoms were attributed to a renal infection. However, on the fifth day the chyle reappeared, the general condition of the patient improved, and within two weeks the chyluria was constant and as marked as formerly. The patient refused further cystoscopy and although the blood and spinal fluid Wassermanns were negative, iodides were given, also three injections of 0.45 gram neosalvarsan. This medication did not apparently influence the condition. By this time the patient had regained his former strength and weight and was feeling well. He left the hospital December 10, 1929, since which time he has taken no medication and when last seen, one year ago, his chyluria was still present and his general health good.

DISCUSSION

Chyluria may be filarial or non-filarial in origin. When non-filarial it has been designated "European chyluria." This term should not be used, as non-parasitic chyluria is not geographically limited to Europe. Much uncertainty exists as to the actual frequency of non-parasitic chyluria. Goebel,[7] in 1921, collected seventy-three reported cases, chiefly from European sources, and Kutzman,[16] in 1925 stated the total number of instances of non-parasitic chyluria was well over one hundred. Luedke,[20] in 1908, could find but ten cases he considered non-parasitic in type, and Hampton,[6] in 1920, concluded there had not been reported more than twelve un-

questioned instances of this disease. Probably many cases reported as non-filarial in origin are really the result of a filarial infection. The chief contributing factors to such a confusion are first that negative blood and urine findings for the embryos of the filariæ of Bancroft were often considered sufficient to eliminate a filarial etiology; and second a lack of appreciation that there may occur in true filarial infections a varying intermittency in the appearance of the chyluria, the periods of latency often covering several years, as well as a delay in the appearance of the chyle in the urine until many years after the primary infection. The presence of a filarial infection must be sought in every case of chyluria regardless of the history. Chyluria in a patient who has ever inhabited a tropical country where filariasis is frequent or endemic, should be considered non-filarial in origin with caution, even though most careful investigation should fail to disclose other evidences of filariasis. An active filariasis may not exist at the time of the examination and yet the lymphatic changes be the result of a previous filarial infection. It does not follow, however, that every instance of chyluria occurring in individuals inhabiting the tropics need be filarial in origin as in Valverd's[33] case studied in South America the chyluria was of bladder origin, the result of a gumma penetrating the bladder wall and opening into a lymphatic channel. Further true filarial infections have been observed in semi-tropical regions as in Southern Europe and Southern United States.[8] Those authors reporting the larger number of nonfilarial cases, included reports from these territories, and it seems probable a filarial infection was responsible for a greater number of the cases than their figures would indicate.

In both the filarial and non-filarial cases of chyluria this symptom usually appears suddenly and there is no regularity in the influence of posture, position, diet, or exercise upon the presence of the chylous urine that is of differential diagnostic value. In each instance it may exist for years without apparent deleterious influence upon the patient's general health. Magnus-Levy[23] quotes Rayer as having referred to an instance of chyluria of fifty-five years' duration without appreciable harmful effects. Young[37] in an excellent and thorough study of two cases of chyluria found the general protein metabolism was not affected by the continued loss of lmyph and repeatedly it has been demonstrated there is in-

sufficient fat loss to influence the patient's health materially. Mechanical obstruction to the lymph circulation, whether due to a specific filarial infection or to some other factor, will result in a chyluria in exactly the same manner. It seems at present impossible to make a differential diagnosis, from the urinary symptom, between a tropical and a non-tropical chyluria. The importance of an instance of non-parasitic chyluria and any variation from the usual in its clinical symptoms will depend upon its cause.

Various conditions and diseases have been observed associated with non-filarial chyluria. While in certain instances the relationship may be that of cause and effect, in others the coexistence must be but coincidental.

The presence of chyle in the urine has been repeatedly observed in pregnancy or the early days of lactation. Not infrequently diabetes and chyluria coexist. Infections as diphtheria, tuberculosis, lues, colon bacilli infection, malaria, perirenal abscess have been associated with chyluria. Echinococcus cysts, parasitic infections, pressure upon the chyle passages from neoplasms, occlusion of thoracic duct, pernicious anemia and numerous other diseases have been thought responsible for certain instances of chyluria.†

A review of the autopsy and operative records in non-filarial cases impresses one with the little conclusive information offered in explaining the actual cause of the non-filarial case. MacKenzie,[22] Havelberg[11] and Igakuschi[14] have recorded dissection and postmortem findings in filarial disease of the lymphatics and have clearly demonstrated how they influence the circulation of the chyle. Magnus-Levy, in commenting upon the cause of non-filarial chyluria, assumes that "chyluria rests upon an anatomic basis of an affection of the lymph vessels," and while "we know nothing about the mechanism of the lymphatic changes, an infectious origin is evident for many cases when the collected facts about European chyluria are considered." In others a mechanical obstruction to the thoracic duct, until collateral lymph circulation is insufficient to compensate, may result in an engorgement of the visceral lymph channels, with the development of a chyluria. Anatomical demonstration of such lymph vessel changes is difficult. They are in life

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†Kutzman cites specific instances of this association of various diseases and chyluria and Magnus-Levy discusses their importance in its development.

but "damned up masses and are collapsed and invisible after death." Again the importance of the break in the collateral circulation of the lymph is emphasized, in the development of chyluria, in the records of those instances of "dilatation and stasis of the thoracic duct caused by cancer, in which death occurred before the lymph circulation has failed." Roberts[29] in his case of discharge of chyle from the abdominal wall observed "enlarged, dilated, lymph channels" but was unable to detect any factor causing an interference with the lymph flow. Fletcher clinically considered his patient as tuberculous and at operation he found distended lacteals accompanying each internal iliac vessel without detecting anatomic evidence of marked thoracic duct obstruction and concluded "the chyluria was probably due to a ruptured lacteal into the bladder caused by an old inflammatory or abscess change." Careful histologic study of the lymph channels in each instance of non-parasitic chyluria coming to autopsy should be made. Only information thus acquired can eliminate the uncertainty now existing as to the immediate cause of the condition.

Magnus-Levy,† in a masterful review of the subject of non-parasitic chyluria, maintains there is always an abnormal communication between a dilated lymph vessel or a lymphatic ganglion and the urinary passages, a conclusion originally expressed by Carter.[3] Since the appearance of the work of Magnus-Levy, clinical data have appeared from time to time to substantiate his statement. Wood[36] has radiographically demonstrated by the retrograde flow of his pyelographic media in a case of chyluria of kidney origin, the point of lymphatic communication with the kidney pelvis, and the literature contains many records of the observation of chyle entering the urinary tract through the bladder. It may be difficult to locate the actual point of communication at post-mortem examination. The openings are small, often pinpoint in size, and although they may be multiple, as in the writers' case, they would necessarily escape any but the closest dissection. Again the fistulous tract may be sinuous and break into the urinary channel at a point some distance from the dilated and varicosed lymph vessel.

Chyle may enter the urine in the kidney, the ureter, the bladder, or according to Hartmann-Keppel[10] in filariasis of the scrotal

†The various other theories as proposed by Rayer, Prout and Marion as explaining the development of chyluria are discussed and the weak points in their arguments pointed out by Magnus-Levy.

lymphatics it may enter through the vas deferens into the urethra. If the upper urinary passages are involved it may be unilateral or bilateral. It may vary in its point of entry in the same case at different times. The observations of Hartmann-Keppel, Hertz,[12] Low[18] and possibly Havelberg would indicate the chyle may enter both the upper and lower urinary tract at the same time. In the writers' case there were three points of entry of the chyle into the bladder; and while all three were observed to emit chyle, it was never seen coming from any two at the same examination. Welfeld,[34] in his case, a twenty-three year old woman, observed the chyle at one cystoscopy coming from the right kidney while later it was seen coming only from the left side. These observations would indicate, in a striking manner, the possible variation in the anatomic location of the chylous fistula in every case and it should be considered in contemplating ablative surgery upon the kidney in a demonstrable unilateral renal chyluria.

Chyle was detected coming from one or both ureters in the cases of Wood, Sanes and Kahn,[31] Lower and Belcher,[19] Stuertz,[33] Kutzman, Welfeld, Sandston,[30] Alessandri[1] and Hampton.[9] While these observations have been referred to in the literature as non-parasitic in origin, when one studies the case records closely, it would seem that probably only the cases of Wood, Sanes and Kahn, Welfeld's two cases, and the case of Hampton can be so considered with any assurance. Kutzman's patient was a native of South Carolina where filariasis is not unknown (Guiteras). Block,[2] Luedke, Fletcher,[6] Valverde, Hertz, Remlinger[28] and Pope[27] have each observed chyle enter the bladder at cystoscopy through a vesical fistula. The cases of Hertz and Pope, however, cannot be classified as non-filarial in origin and while Remlinger studied two cases of chyluria which he considered the result of pressure upon the base of the bladder due to echinococcus cysts, these were observed in Morocco, where filariasis is not uncommon. The autopsy findings of Havelberg and Low indicated the chyluria had been of bladder origin in the former, and from both the kidney and bladder in the latter. Their relation to a filariasis, as is true in the observations of Nunami and Sato,[25] Oehme[26] and Hnatek[13] cannot be determined from the case reports.

Treatment of non-filarial chyluria should be directed toward its cause if this can be determined. At present our knowledge will

not permit of generalization in the management of these cases. The treatment of each will depend upon the particular problem presented. While chyluria is not a dangerous condition, oftentimes the pain and discomfort accompanying the passage of clots become a serious problem. It would seem there is need for investigation and experimentation in an attempt to control such clotting. Any measure, whether regulation of diet and keeping the fats to a minimum as suggested by Magnus-Levy, or drug therapy influencing the reaction, the concentration, the mucin or the fibrin content of the urine as proposed by others, should be undertaken until a reliable means of preventing the clotting finally may be secured.

Arsenicals used intravenously have been employed in many instances with varying success in controlling the chyluria whether filarial[17] in origin or not.[4]

If the chyle is coming from the kidney and there is pain and discomfort incapacitating the patient, if sufficient time and study seem to have definitely limited the disease to one side, nephrectomy may be advisable.[15] Exploratory operations upon the kidney have been performed but have added little to the patient's comfort or to our knowledge of the disease.

In chyluria of bladder origin, fulguration or cauterization of the point of entrance of the fistula into the bladder has been done by Block and Fletcher with complete success in the former and but partial success in the latter case. Such a method of treatment in the writers' case was without result. Arsenicals in vesical syphilis as in Valverd's case of gumma of the bladder, resulted in a cure. In our case antileutic treatment was without effect.

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CHRONIC PHOSPHATURIA

A REPORT OF TWO UNUSUAL CASES

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My object in reviewing two cases of permanent phosphaturia is to illustrate the severity of the condition which we are accustomed to consider essentially in the light of a sign or symptom. I have no figures as to its incidence but in a review of 2,500 office records the cases which I am reporting are the only ones encountered or at least recognized clinically. In discussing the occurrence of this condition with my colleagues I am impressed with its apparent rarity.

Perusal of the literature and textbooks is very confusing. It would seem probable that there are several varieties, for the condition has been recorded by various observers, both with and without urinary symptoms—of transitory or of long duration—and often with symptoms of intestinal dysfunction, neurasthenia, and prostatitis (Ravogli,[22] Van Domarus,[26] and Grimaldi[16]). Inspired by lack of uniformity of nomenclature, Laidly[18] has recently endeavored to clarify the situation and has proposed a simple classification, based on a thorough review as well as on scientific investigation. His analysis should provide a working basis for a better understanding of a vague disorder.

Clinically, at least, phosphaturia may be regarded as a spontaneous deposition of phosphates anywhere in the urinary tract so that the urine as it passes, or immediately on being passed, is thick and milk-like. It has been regarded as both a physiologic and pathologic phenomenon and may be either temporary or permanent.

Temporary phosphaturia is usually transitory and secondary to dietetic factors. It occurs at the height of digestion and as a result of the ingestion of foods rich in base-forming elements, and from the administration of alkaline drugs. According to Baehr,[5, 6] conditions which exact gastric secretion and persistent vomiting likewise may produce the condition.

Permanent phosphaturia is of two varieties, depending on the cause. That which is incidental to bacterial activity for the increase

in alkalinity of the urine is regarded as a bacterial phosphaturia, and that which is supposedly due to some perversion of elimination whereby the large bowel fails to excrete its share of earthy phosphates is regarded as true phosphaturia (Laidly[18] and Baritz.[7])

THE RÔLE OF PHOSPHATES

Some reference to our present conception of the source of phosphates and their excretion is pertinent to an appreciation of the probable mechanism of phosphaturia in general.

Fig. 1 *(left)*. Shadow in left renal area.
Fig. 2 *(right)*. Left pyelogram with inclusion of original shadow in lower calyx.

Phosphorus is derived essentially from food. The total amount of phosphorus ingested per day is between 1.2 and 2 grams. The dependence of phosphorus excretion on the diet is well illustrated in the experiments of Folin (Mathews).[21] On a diet containing 16 grams of nitrogen per day the excretion in the urine was 4.1 grams of phosphorous pentoxide in twenty-four hours. A week later on a diet of cream and starch containing 3.9 grams total nitrogen the urinary phosphorous pentoxide was 1.1 grams. The phosphates have an extremely important rôle in the maintenance of a normal state of equilibrium of body tissues. This is maintained by the

presence of so-called "buffer" substances, representing the salts of carbonic acid, phosphorus, and proteins. The excretion of these elements is a result of an effort of the tissues of the body to maintain a constant reaction which is slightly alkaline or neutral, the hydrogen ion of the blood being remarkably constant. The ability of the blood to combine with acids is called the alkali reserve. Elimination of the excess hydrogen ions must therefore take place through the lungs and the kidneys, the carbon dioxide being eliminated through the lungs and the acid phosphates through the kidneys. During digestion, while gastric juice is being secreted, there is an alkaline tide in the body due to the separation of the hydrochloric acid. The sodium of the sodium chloride which has undergone decomposition finds it way into the blood as an alkaline phosphate or carbonate. The phosphates thus formed are eliminated by the kidneys as acid or basic phosphates of the various metals, namely the sodium, potassium, calcium, and magnesium group. Not all the phosphates, however, are eliminated through the kidneys. In human beings from 50 to 65 per cent is eliminated in the urine and from 30 to 50 per cent in the feces.

THE INFLUENCE OF NORMAL AND PATHOLOGIC PROCESSES IN METABOLISM OF PHOSPHORUS AND CALCIUM

I have reviewed some of the more recent literature on the biochemistry of phosphorus and calcium, as related to normal and pathologic conditions, in the hope that some information regarding the cause of permanent phosphaturia may be forthcoming. The scope is tremendous. The factors concerned with the absorption and elimination are complex and not entirely understood. A consideration of the metabolism of phosphates cannot be made without reference to calcium, as the relationship and interdependence of these two elements are so allied as to be almost inseparable.

The circumstances which determine whether phosphate shall be eliminated through the urine or feces are in part, according to Forbes and Keith,[15] as follows:

1. The reaction of the contents of the alimentary tract as determined by hydrochloric acid and carbonates.

2. The nature and relative amount of the other mineral elements, especially the bases present in the digestive tract, as affecting the solubility of the phosphates.

3. After the absorption of the phosphates from the alimentary tract, all of those circumstances which control the secretion of the phosphates into the digestive tract and the re-absorption of the same.

4. The many circumstances which affect the reaction of the blood serum and the amounts and proportion of the other salts present, as affecting the form and therefore the solubility of the phosphates, the more readily soluble tending to go through the urine.

Studies of the feces while fasting and during feeding of milk and meat lead to the belief that a considerable quantity of phosphorus in feces has an origin other than in food. With a lime-poor diet the feces are said to be poor and the urine rich in phosphates. Salter[24] et al. concluded that the addition of inorganic phosphates, either the acid phosphate, basic phosphate or a mixture of these two salts, to a controlled diet resulted in no appreciable change in the endogenous calcium excretion, either fecal or urinary.

Farquharson[13] et al. showed that even with a great variation in the phosphorus intake, and therefore in the phosphorus calcium ratio, the excretion of calcium in either urine or feces was not materially affected.

It is known that certain pathologic processes influence the retention and elimination of phosphorus. There is an increase of phosphorus in the urine during the catabolism of nucleins, during the absorption of pneumonia exudates, and in starvation. The amount of elimination is increased in wasting diseases such as tuberculosis, severe anemias, yellow atrophy, and during pregnancy. The calcium and phosphorus excretions are abnormally high in hyperthyroidism, although the blood calcium and phosphorus levels are normal. The increased phosphorus excretion with thyroid feeding is entirely in the urine. The increase in calcium excretion in the feces is an unique effect of thyroid, as other methods of increasing calcium excretion affect urinary excretion alone.[1]

Numerous investigators have noted the retention of phosphorus with renal injury. Schulz[25] carried out a series of well controlled experiments on the excretion and retention of phosphorus in normal individuals and in patients with renal disease, and concluded that in renal disease the excretion of phosphorus is diminished. He prepared a solution made of an acid and alkaline sodium phosphate and

regulated it to a hydrogen ion concentration close to that of blood. This he injected intravenously and noted the effect of the solution on the level of phosphates in the blood and the amount excreted in the feces and urine. He observed that following the injection there was an increase in the amount of inorganic phosphates excreted in the urine and the amount of phosphates excreted in the feces, the amount of phosphates in the urine being much greater. He further noted that the amount of calcium excreted in the feces was not appreciably affected by the injection of the solution of phosphate.

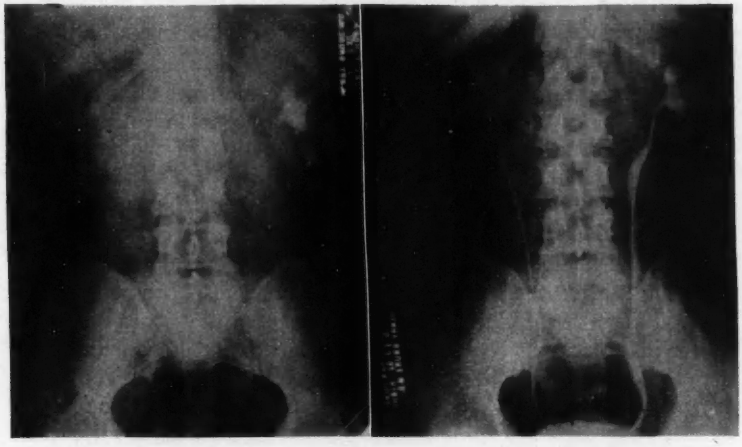

Fig. 3 *(left)*. X-ray of urinary tract taken twenty-nine months later, showing multiple shadows in the left renal area.
Fig. 4 *(right)*. Inclusion of shadows on left pyelogram.

When calcium chloride was given orally in doses of from 4.5 to 5 grams the calcium did not draw any phosphorus from the blood into the intestine, even when the blood was laden with phosphorus through the intravenous injection of sodium phosphate. Consequently the ingestion of calcium chloride does not alter the path of excretion of phosphorus in cases of retention of phosphorus. Neither does the ingestion of calcium chloride affect the level of phosphorus in either urine or blood. It is reflected by a considerable rise in excretion of calcium in both urine and feces.

Normally an individual is said to require 0.7 grams of calcium in

twenty-four hours. If the calcium intake is low, as compared with the phosphorus, an abnormal irritability of the nervous system is produced resembling tetany and epileptiform attacks.[21]

Experimental evidence indicates that the parathyroid gland acts in a way that increases the amount of calcium in both blood and urine. Tetany, resulting from extirpation of the parathyroid glands, is thought to be due, in part at least, to the retention of phosphoric acid which is normally counteracted by calcium. With parathyroid tetany, both calcium and phosphorus excretion in the urine is reduced, but the fecal excretion remains normal. Greenwold and Gross, quoted by Boothby,[10] showed that the excretion of calcium in the urine was markedly increased following the administration of large doses of parathormone.

In hyperparathyroidism there is a high blood calcium and low blood phosphorus. It is supposed that the parathyroid hormone lowers the threshold for phosphorus excretion in the urine and, according to Albright,[2] the calcium changes in parathyroid dysfunction are secondary to phosphatic changes. On the basis of this hypothesis Albright et al.[2] report beneficial results from the ingestion of phosphates in the treatment of hyperparathyroidism.

While the greater portion of calcium and phosphorus excreted is derived from the food, the body draws upon the bones when the diet is inadequate. The observations of Aub and Farquharson[4] on the calcium and phosphorus metabolism of a group of bone diseases are very interesting. In general, contrary to what one might deduce, they noted nothing grossly abnormal in the blood level or in the excretion of calcium or phosphorus. It appears that calcium and phosphorus may be liberated from one part and deposited in other bones without any apparent loss.

Hypercalcemia can be brought about experimentally by giving sufficiently large doses of viosterol, even with almost complete absence of calcium from the diet. The hypercalcemia thus produced can be reduced by the intravenous injection of sodium bicarbonate, following which there is a marked excess of calcium and phosphorus in the lungs and kidneys.[11]

Our knowledge of the principle concerned in the elimination of calcium and phosphorus is too meager to permit an explanation of the physics of secretion. It is known that both phosphorus and calcium may be present in the blood stream in concentration greater

than their threshold for secretion. It is apparent from the work of Marshall and Crane,[20] who studied the influence of vascular changes in the kidney on the elimination of various substances, that there are several factors which must be taken into consideration. They noted that the chlorides and bicarbonates are eliminated entirely by filtration along with the other non-colloid constituents of the urine, while urea, phosphates, sulphates and creatinin are mainly excreted by a process of secretion. All of the non-colloid constituents of the plasma are eliminated by filtration through the glomerulus, urea, phosphates, sulphates and other bodies being added to the filtrates by the secretion of the tubular epithelium. The water, chlorides, and the carbonates are re-absorbed during the passage along the tubule. The amount of absorption of bicarbonate is largely dependent on changes in hydrogen ion concentration of the blood. By means of anemia brought on by temporary closure of the renal artery they observed that there was a marked diminution in the elimination of urea, phosphates, sulphates, creatinin, and ammonia. They further concluded that the two phosphatic ions probably belong to different groups, that is, are differently influenced by changes in blood flow. These observations are interesting from the standpoint of the explanation of calcium elimination. Albright et al.[1] suggest that the increased blood flow in hyperthroidism is a factor in the increased calcium excretion. The excretion of calcium into the intestinal tract is probably not a threshold phenomenon. Berg (quoted by Salter,[24] page 400) is of the opinion that calcium is excreted by the bowel in a tribasic form. Salter,[24] however, noted that the fecal inorganic phosphates were excreted chiefly as the disodium salt, regardless of the form in which it was fed.

TEMPORARY PHOSPHATURIA AND FACTORS PERTAINING TO IT

The chemistry of urine is very complex. Even the factors pertaining to its stability are incompletely understood. Phosphorus is found in the urine wholly in the oxidized form of orthophosphoric acid and is present as the salts of the alkaline and earthy metals and free phosphoric acid. The sodium and potassium phosphate constitute the alkaline group and the calcium and magnesium the earthy group. The salts of these metals exist as a mono- and disodium, or potassium phosphate, and as a mono- or dicalcium,

or magnesium phosphate respectively, and occur in the relative ratio of 2 to 1 in the average single specimen. The salts of the alkaline metals are the most important inorganic elements of the urine. They are freely soluble, stable, and subject to wide variation as to amount and character. Their presence is responsible for the reaction of the urine. An excess of one or the other gives rise to an acid or alkaline urine; the relative amount being dependent on the character of the food ingested. As stated by Laidly,[18] the P^H of the monosodium phosphate is 4.82 and therefore distinctly acid, whereas the disodium phosphate is slightly basic, having a P^H 7.45. This degree of acidity is within the limits of the variation of normal urine.

Normal human urine is usually acid to litmus, though it may be alkaline at times. The reaction runs parallel to the character of the food. It is most acid on a meat diet, whereas on a vegetable or fruit diet it may be neutral or alkaline. This is explained on the basis that the protein in meat contains unoxidized sulphur, together possibly with esters of phosphoric acid. In the process of metabolism they are oxidized to sulphuric acid or set free as phosphoric acid. Under such circumstances the urine contains more free phosphoric acid and monosodium phosphate and is consequently acid in reaction. Vegetables and most fruits contain acid salts of dibasic acids, polybasic acids or carboxylic acid, which, on oxidation in the body, are burned to carbonates. The feeble carbonic acid is eliminated by the lungs to a large extent, leaving the base, which is usually sodium or potassium, to find its way into the urine. Consequently the proportion of disodium phosphate formed and eliminated is greater and an alkalinity of the urine results.

With an increase in the alkalinity of the blood and tissues, either by natural or artificial means, the excess alkali is excreted by the kidneys in the form of dibasic sodium phosphate. The preponderance of dibasic sodium phosphate renders the urine alkaline. If the alkalinity goes beyond a certain concentration, the dicalcium phosphate is precipitated and is insoluble in an excess alkali.

$$Na_2HPO_4 + Ca\ (H_2PO_4)2 \rightarrow CaHPO_4 \downarrow + 2NaH_2PO_4$$

Any factors which may increase the alkalinity of the urine will have the same effect. This is precisely what happens in a bacteriuria, with urea-decomposing bacteria. The liberation of ammonia

causes an alkalinity which results in the precipitation of an insoluble double salt of calcium, magnesium, ammonium, phosphate.

Unfortunately the picture is not complete, for it is known that even within the limits of alkalinity of urine a precipitation of earthy phosphates does not necessarily take place. This paradox is difficult to reconcile with the assumption that phosphaturia results from the chemical interaction of salt as a result of excess alkalinity. It may, however, be explained on the basis of catalysis. This latter mechanism is dependent upon some inherent factors, one of which we term protective colloid. No attempt will be made here to elaborate on colloids other than to state that the colloidal solution of metals belongs to the class of suspensoids which form rather dilute, unstable sols, which are easily precipitated from solution. One of the peculiar properties of colloid is that the dispersed particles of the substance (solute) are sufficiently large to separate the molecules of the solvent beyond the range of their cohesional attractions.[21] This produces the surface and surface tension. Those factors which cause a decrease in surface tension are presumed to lessen the protective colloid property, and consequently favor the precipitation of the earthy metals.

Recent researches cast some doubt on the importance of the alleged protective colloids.

As a result of his own observations, as well as those of other investigators, Eisenstaedt[12] concludes that in the etiology of urinary lithiasis the so-called protective urinary colloids may not play the important rôle ascribed to them. He is inclined to attribute the hydrogen ion concentration as the material factor in the precipitation of urinary salts. It appears, therefore, that the hydrogen ion concentration, together with some occult factor previously regarded as a protective colloid, is the principle which determines temporary phosphaturia.

It has been observed that the precipitation of phosphates may be an instantaneous reaction. That it can take place anywhere along the course of the urinary tract or immediately following urination has been attested by various workers. Both Beer[9] and Laidly[18] have noted such unusual occurrences as unilateral renal phosphaturia and urethral phosphaturia and are inclined to favor the idea that it is a local phenomenon. Indeed, Laidly concludes that if the hypothesis is granted that alkaline urine is secreted by the kidney, with all

the phosphates in solution, the conclusion that some local influence determines phosphaturia becomes inevitable.

CHRONIC PHOSPHATURIA

A distinction between a permanent phosphaturia resulting from infection and a permanent, non-infective phosphaturia is significant. While the urinary manifestations may be indistinguishable from the standpoint of treatment, the necessity of accurate diagnosis is obvious. The local symptoms result almost entirely from excess alkalinity, for it is generally accepted that tissues are intolerant to a constant exposure to an alkalinity greater than a fixed concentration. I believe this applies particularly to the mucosa of the urinary tract. Our knowledge of the prevalence and distribution of urea-decomposing bacteria is becoming better understood. Laidly demonstrated, in a study of 211 cultures, 200 of which were obtained from infected urine, that fifty-four, or 25.6 per cent, were found to split urea. Of the fifty-four urea-splitting organisms, twelve were cocci and forty-two bacilli. He determined that the property of splitting urea was relatively more frequent among the cocci than among the bacilli. Eisenstaedt[12] has made similar observations. The importance of the adnexa in the rôle of harboring urea-splitting bacteria, and the subsequent alkalinization of the urine with the precipitation of the earthy phosphates, becomes apparent. Symptoms of prostatitis as well as neurasthenic manifestations can be easily reconciled with this type of phosphaturia. If the condition is of local origin, secondary to bacterial action, one would not expect to find any radical variation in the quantity of inorganic urinary constituents. This is precisely in accord with the result of chemical investigations of Laidly, whose analysis revealed that both the alkaline and earthy phosphates content of the urine of patients with infected phosphaturia are well within the limits of normals.

NON-INFECTED PERMANENT PHOSPHATURIA

It is generally stated that non-infected permanent phosphaturia is associated with a failure on the part of the large bowel to excrete its share of the body's calcium. Observations along these lines have not been sufficiently numerous or complete to substantiate the assertion, although biochemists have observed that the proportion of calcium in urine increases in constipation, whereas the proportion in

the feces increases while that in the urine diminishes in diarrhea. Renner[23] suggests that the phosphorous pentoxide-calcium oxide ratio must be below normal in order for the earthy phosphates to precipitate. He offers the explanation of the increase of the earthy phosphates on the basis that an increase in the calcium oxide content of the urine causes a formation of the disodium and dipotassium phosphate at the expense of the monosodium and potassium salts. Laidly believes, if this assumption is correct, that permanent phosphaturia will be caused by an increase in the earthy phosphate content of the urine. His study of nine specimens of urine from cases of permanent non-infected phosphaturia attests to this hypothesis. Here again, however, the fact that there is an increase in the earthy phosphate content of the urine does not necessarily indicate a clinical phosphaturia; for an increase in earthy phosphates has been noted in an acid urine without any precipitation of the phosphates. This has been explained on the basis of the variability of the protective colloid.

I shall present and discuss two extreme cases of permanent phosphaturia occurring in the upper and lower urinary tract respectively, and presumably non-bacterial in origin.

CASE REPORTS

Case 1.—The first case is that of a man thirty-nine years of age, who sought medical care because of recurrent attacks of pain in both renal areas, frequency of urination, the passage of gritty material, and milky urine. He stated that up to seven years ago he had enjoyed good health except for chronic constipation and an accident fifteen years previously, when he had been severely burned in an oil well explosion. The present symptoms came on insidiously with bladder irritability, right renal pain, and the passage of gritty material. For an interval of five years from the onset he passed numerous friable stones, frequently associated with pain in the right kidney and the passage of milky urine. The frequency and burning on urination occurred independent of renal colic. During these five years he was under the care of various physicians. He had ureteral dilations "too numerous to keep count of." The instrumentation gave temporary relief from kidney pain but aggravated the bladder. During the past two years he had had but one attack of renal colic followed by the passage of a blood-tinged stone. The irritability of the bladder and the passage of milky urine have persisted. He has observed that, with the consumption of alcoholic liquor over a period of time, the urine has cleared up and he has been relatively free from bladder discomfort. About five months

ago there was a recurrence of pain in the right renal area. The frequency and nocturia have increased. Three weeks ago he developed pain in the left renal area which was relieved by drinking large quantities of water, though he still has some residual discomfort. In the past five months he has lost about thirty-five pounds in weight and since the recent attack has been unable to work.

General examination showed a well developed and well nourished man, with extensive scar on the right arm, neck, shoulder and back. The physical examination was essentially negative except for tenderness on deep palpation over both renal areas, the blood-pressure was 140/100, external genitalia negative. The patient passed urine freely; the first glass was turbid with numerous shreds, and the second glass was turbid. Analysis of passed specimen of urine revealed a specific gravity of 1.020, alkaline reaction, trace of albumin, no casts, no red blood cells, a rare leukocyte and a heavy amorphous deposit of phosphates. A dense precipitate occurred on heating, which disappeared on the addition of acetic acid. A portion of the urine which was left standing for several hours developed a heavy precipitate. The patient was sent to hospital for further study and cystoscopic examination. Routine blood and blood Wassermann were negative. An X-ray of the kidneys, ureters and bladder was negative except for a small staghorn shaped shadow in the left renal area, approximately 1 by 0.5 cms. (Fig. 1.) Cystoscopic examination revealed a slightly diffuse chronic cystitis with normal bladder capacity. With indigo-carmine given intravenously there was a normal concentration of dye returned in three minutes from both meatus. Both ureters were catheterized without difficulty and specimens were obtained for microscopic study, stains, and cultures. Bilateral pyelograms were made. Analysis of the urine obtained through the cystoscope showed a specific gravity of 1.010, trace of albumin, numerous triple and amorphous phosphates, and epithelial cells, and an occasional pus cell. Stain and culture were both negative. Urine obtained from the right kidney showed an occasional pus cell and a few epithelial cells. The culture showed numerous colonies of Gram-positive staphylococci.

A specimen of urine obtained from the left kidney showed a rare pus cell, numerous epithelial cells, a negative stain and a negative culture. My first impression was that we were dealing with a kidney and bladder condition which was secondary to a proteus ammonia infection similar to a case we[17] reported in 1925. Efforts made to isolate and identify this organism were unsuccessful. It will be noted that the culture from the right kidney was positive for a Gram-positive staphylococcus. Both the left kidney and the bladder specimens were negative. Only one bladder specimen, however, yielded a staphylococcus organism and it was thought that the occurrence in this instance, as well as in the specimen of urine from the right kidney, was a result of contamination. The right pyelogram showed a moderate pyelectasis.

The left pyelogram was normal in outline and included the original shadow, which was apparently situated in the tip of one of the lower calices (Fig. 2). The true nature of the disease was not apparent, but, on the basis of our previous experience with the treatment of alkaline encrusted cystitis, we instituted a diet high in acid-forming ash together with the ingestion of ammonium chloride, 15 grains three times a day. Because of chronic constipation and the patient's unsatisfactory experience with a variety of cathartics he was permitted to continue drinking Garfield Tea.

On December 28, 1929, approximately five weeks from the time of his first visit, he had a right renal colic and passed a calcareous slug. He had experienced no discomfort from taking the ammonium chloride and stated that the bladder irritability was very much lessened. At this time the urine was neutral to litmus and, according to the patient's statement, was clear most of the time. The patient was obliged to leave town and was not seen again for a period of two years, when he returned at my request. At this time, January 14, 1932, he stated that his general health had been excellent. He weighed 208 pounds and had no subjective urinary symptoms. Except for a recent gastric upset accompanied by headache, which he attributed to exposure to gasoline and gas fumes in his work, he had no complaints. He stated that he took the ammonium chloride tablets for almost a year and had been on a liberal diet of meats, fish, eggs, and cereals since last seen. He further stated that he had had none of his previous symptoms and that his urine had been clear, except on rare occasions when he had had a cold.

General examination at this time was essentially negative except for a slight elevation of blood pressure—160/110. External genitalia were negative, the prostate per rectum was negative, nothing was expressed. The first specimen of urine was clear with numerous shreds, and the second glass was clear. His urine was acid and contained an occasional pus cell. A chemical analysis of a passed specimen of urine showed:

PH 5.8

Total phosphates as P_2O_5	2.03 mg. per c.c.
Alkaline phosphates	1.43 mg. per c.c.
Earthy phosphates	0.6 mg. per cc.
Ratio of alkaline to earthy phosphates	2.3 to 1

An analysis of a portion of a twelve hour specimen collected ten days later showed:

PH 6.6

Total inorganic phosphates as P_2O_5	1.1 mg. per c.c. urine
Alkaline phosphates as P_2O_5	0.75 mg. per c.c. urine
Earthy phosphates as P_2O_5	0.35 mg. per c.c. urine
Ratio of alkaline to earthy phosphates	2.1 to 1

An X-ray of the areas of the kidneys, ureters, and bladder showed a single shadow which apparently filled the pelvis, and diffuse opacities which involved what would appear to be the greater portion of the left kidney (Fig. 3).

The patient declined cystoscopic study and was not seen again for three months, at which time he was convalescing from a severe cold and bronchitis, brought on by refrigeration and exposure. During the past few days he had complained of a burning and frequency of urination. A passed specimen of urine contained a moderate number of pus cells. A cystoscopic examination on April 13, 1932, revealed an irritable bladder with a slight, diffuse cystitis. With 10 c.c. of indigo carmine given intravenously there was a normal concentration of dye returned in normal time from both kidneys. That from the left was somewhat less in color intensity. The ureters were catheterized without difficulty and specimens were obtained for microscopic study and culture. Both ureteral specimens contained numerous leukocytes. A stain of the sediment showed numerous Gram-negative bacilli. On culture a growth of colon bacilli was obtained from both kidney specimens, as well as from the bladder urine obtained through the cystoscope. A plain film of the urinary tract and a left pyelogram were made. The original shadows were included in the outline of the pyelogram, which showed a marked dilatation of all the calices (Fig. 4).

Case 2.—The second case is that of a middle-aged woman, who was referred for a consideration of interstitial cystitis. She was married, and had two children. Except for chronic constipation the antecedent history was of no consequence until the present illness, which began five years ago, with acute bladder symptoms that persisted for about six months. Since then she has had daily paroxysms of marked frequency and burning. This has been accompanied by extreme nervousness. The urine has been of low specific gravity without cellular elements. Occasionally there have been interval attacks with hematuria and pyuria. The patient has been under the care of numerous urologists without relief. A complete examination and urologic study elsewhere was negative except for a moderate right hydronephrosis. There had been no symptoms referable to the kidneys but, on the assumption that the renal stasis might have some bearing on the bladder condition, a right nephrectomy had been done. Surgery was not followed by any improvement of the symptoms.

General examination at this time was essentially negative except for the patient's marked nervousness. The external genitalia were negative, urine obtained through a catheter showed a specific gravity of 1.014, faintly acid to litmus, a trace of albumin, no sugar, no casts, a few pus cells but no bacteria. There was a very heavy deposit of triple and amorphous phosphates. A cystoscopic examination was carried out which revealed a normal bladder capacity. There were multiple areas of cystitis cystica in the left posterior wall and the whole of the trigonum. On the surface of these areas in the trigonum there were numerous adherent, phosphatic excrescences, some of which could be removed by the force of the irrigating fluid. The remainder of the bladder was negative. Distention with over 300 c.c. of irrigating fluid

revealed no areas akin to interstitial cystitis, nor was any bleeding produced by overdistention. There was a definite granular urethritis which extended to the internal sphincter. The left kidney was not catheterized. An X-ray of the area of the bladder was negative and a cystogram showed a bladder of normal capacity with normal contour. On the morning following the cystoscopic examination, the urine was markedly alkaline, with numerous pus cells, amorphous and triple phosphates, and the urinary discomfort was exaggerated. In the belief that the areas of granulation in the urethra might in part account for the urgency and frequency, it was decided to destroy them by means of electro-coagulation. This procedure was carried out under nitrous oxide anesthesia. Ocular inspection of the bladder at this time showed a diffuse precipitation of phosphatic material over the bases and trigone of the bladder. The urine from the left kidney was clear. A diagnosis was made of chronic phosphaturia, moderate cystitis cystica, and granular urethritis.

COMMENT

It will be recalled that the first patient presented a classical, clinical history of phosphaturia over a period of seven years, occasionally accompanied by renal colic and the passage of calcareous slugs. He subsisted for approximately two years on a high protein diet and took ammonium chloride regularly during the first year. The urinary symptoms for which he originally sought relief disappeared entirely. Both the patient and I regarded the condition as cured, until confronted with the X-ray evidence.

I am inclined to the belief that the formation of stones in the kidney can be regarded as the result of a primary phosphaturia. Just what the relationship may be between the acid-forming ash diet, the ingestion of ammonium chloride, and the rapid formation of the calculi in the left kidney, I am unable to say. One would naturally infer that some disturbance in the acid base mechanism must have been a factor in augmenting the renal or urinary instability. This would be in accord with the contention of Eisenstaedt.[12] I do not regard the present condition as a coincidence, nor as a stage in the period of development of stone-forming kidneys. Even though it were the latter it is evident that something transpired to enhance the process.

Therapeutic principles obviously involve something more than altering the reaction of the urine. Aub et al.[3] have observed that ammonium chloride normally causes an increased urinary excretion of calcium and phosphorus. The administration of ammonium chlo-

ride to normal individuals on a low calcium diet produced on the average a four-fold increase in urinary calcium, but no effect on fecal calcium. Farquharson et al.[14] showed that the effect of an acid diet was essentially similar to that of ingested inorganic acid. Acid salts are said to increase the excretion of calcium in the urine.

If we accept the supposition that permanent phosphaturia results in part from a partial or complete inability of the bowel to excrete its share of the body's calcium, then the utilization of thyroid extract might be considered. There is apparently sufficient evidence to warrant the assumption that both calcium and phosphorus are threshold substances. However, the excretion of calcium into the gastro-intestinal tract is not a threshold phenomenon for, in parathyroid tetany with a low serum calcium, there is an unaltered fecal calcium elimination. Both calcium and phosphorus blood levels are increased by the thyroid hormone as a result of mobilization of these substances from the bone, and increased elimination occurs with thyroid feeding. According to Albright,[1] the increase in calcium excretion in the feces is a peculiar effect of thyroid. I have had no experience with it but refer to it as a possible therapeutic measure. However, it is questionable to what extent it is advisable to attempt the elimination of calcium and phosphorus in the presence of phosphaturia, as increased elimination may result in increased precipitation of the urinary salts. Bauer and Marble[8] have shown that irradiated ergosterol increases the absorption of the calcium and phosphorus from the gastro-intestinal tract.

At the time these cases were first observed, I was not familiar with Laidly's hypothesis that permanent, non-infected phosphaturia is apparently characterized by an increase of the earthy phosphates of the urine. In one case, after a period of two years, during which time the clinical manifestations of phosphaturia had not been evident, the chemical study of the urine showed no alteration from the normal in the ratio of alkaline to earthy phosphates.

There is no scientific reason for the acceptance of the hypothesis that non-infected, permanent phosphaturia is a distinct entity. That it is a part of a syndrome occurring as a disturbance of the acid base mechanism and possibly related to some glandular dysfunction, is a conjecture. There is evidence to indicate that both phosphorus and calcium are threshold substances and that their elimination through the kidneys is modified by the character of the rate

of blood flow. Marshall and Crane[19] assert that the non-colloid substances are not equally influenced by the vascular changes in the kidney, and there is some indication that the primary and secondary phosphates are not similarly affected. I am not familiar with any evidence that the earthy phosphates, as such, are ever secreted by the renal epithelium, although Berg is of the opinion that calcium phosphate is excreted by the bowel in the tribasic form.

It seems very doubtful that failure on the part of the large bowel to excrete its share of the body's calcium is the answer to the riddle of phosphaturia. Laidly has observed high percentages of earthy phosphates in acid and clear urine. It would appear that the subjective urinary symptoms are primarily dependent upon the degree of alkalinity of the urine, although the actual precipitation may be governed by the action of some other factors. The suddenness and the evanescence of the attacks are not unlike the occurrence of acute exacerbations in chronic asthma. This similarity is striking in the second case, in which there are paroxysms of bladder irritability. The nervous and even the emotional disturbances that accompany the attacks are striking. From the present evidence, incomplete as it may seem, it appears that the urinary symptoms are dependent on some local phenomenon as suggested by Beer.[9] With the precipitation of earthy phosphates, anywhere along the course of the urinary tract, the symptoms vary accordingly. It seems quite probable that there is some constitutional disturbance accompanied by irritability of the nervous system, though proof is lacking. A scientific study of these cases with the coöperation of the internist, biochemist and urologist is necessary in order to elucidate our knowledge of phosphaturia.

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DISCUSSION

DR. HENRY G. BUGBEE (New York City): Dr. Gilbert Thomas has given us a very thorough and interesting exposition of the problem of genito-urinary tuberculosis. He brought out some practical points, especially the consideration of genito-urinary tuberculosis as part of a systemic tuberculosis.

He also emphasized the fact that patients with tuberculosis are poor subjects for surgery and the importance of the patient building up a resistance before any surgery is resorted to. If patients have built up a resistance, it is often very surprising to see how well they do go through surgical procedures.

Another point he made was in regard to tuberculosis of the epididymis. We have all been apt to jump to the conclusion that that is an isolated lesion, and we treat it as such, especially to the exclusion of the upper urinary tract. I have been surprised, in studying cases more carefully, to find that in a number of instances we had a renal tuberculosis as well as a tuberculosis of the epididymis, although the urinary symptoms were almost *nil*.

I wish to thank Dr. William A. Thomas for the privilege of hearing his very interesting talk. I am sure we are all to be congratulated upon this excellent presentation.

In regard to chyluria, I wish to cite a case under observation some fifteen years ago, of a woman thirty-two years of age, who gave a history of having chyluria when she first began to menstruate. That condition existed for about four months and then stopped. I saw her during two pregnancies. During the first three months after delivery she passed chyle in the urine, and never at any other time. The chyle was passed entirely from the left kidney. Pyelo-ureterograms were negative. I watched her for a number of years after that and she had no return of the chyluria.

I was wondering, in Dr. Hager's cases, whether he took repeated cultures of the urine to prove the point that there was no infection present. It seems to me, that only by taking repeated cultures would it be possible to prove that point.

I have a patient I have been watching for about ten years. I have operated on both kidneys and both ureters for large obstructing calculi. At first the infection was very slight, but we

have always found colon bacilli on culture. The only relief this patient has obtained has been from repeated irrigations of the kidney pelves, which we have done every month for a period of ten years.

DR. JOHN R. CAULK (St. Louis): I, too, have been very much interested in Dr. Thomas's paper.

I recently analyzed 263 cases of renal tuberculosis in our clinic, 115 of which came to nephrectomy. An interesting observation in this series is that compared to the general tuberculosis occurrence there has been a decided diminution in the frequency of urinary tract tuberculosis since 1916. From 1916 to 1930 there was practically a 50 per cent diminution, paralleling the reduction in massive pulmonary and other tuberculous lesions throughout the body, due to improvement in diagnosis and proper therapeutic handling of the cases, and so forth.

Unfortunately, during the last year and a half, on account of the poor living conditions of these depressed times and the increase of general pulmonary and other massive lesions of the body, our renal lesions are beginning to increase again, and now show about 30 per cent instead of 50 per cent, so it is up 20 per cent in the last year and a half.

Following nephrectomy, of course, the relief of bladder symptoms is sometimes prompt and quite responsive, and in all probability depends on the relief of the tuberculin reaction upon the raw surface of the bladder from the products coming from the kidney. About 77 per cent of our cases have shown bladder relief and cure later, from three to ten years. Some of these take time; some are immediate in their response.

The perpetuation of bladder symptoms, of course, depends on many things; I mean either the infiltrated lesions of the bladder wall, its ulcerations, sclerosis of bladder neck, an overlooked lesion of the kidney, and seldom I think the ureteral stump.

Many of these bladder lesions require topical applications and various therapeutic measures. The majority of them improve and go along nicely. Some of them resist all sorts of therapeutic administrations. For this reason, I wish to recite to you and have on record an observation made during the last month, which to me was the most interesting thing I have seen for a long time.

The patient was a young woman, twenty years of age, for whom I removed a kidney many years ago, who had during this time had a persistent bladder irritability, accentuated in the last year or eighteen months by a secondary colon bacillus infection which resisted all types of therapy. We did everything possible we knew for the correction of this lesion.

Being at our wit's end, and believing so implicitly in the effectiveness of fresh air and sunshine, I attempted to "outdoor" her bladder. To do so, we constructed a little device through which air could be injected into the bladder for moderate distention—not forceful at all, of course—and allowed to come out promptly, with the introduction of the ultra-violet rays at the same time, without any other materials being used.

At first we insulated one of the ordinary mercury vapor orificial applicators to protect the urethra and shellacked the ends to protect the bladder, and radiated this bladder and ventilated it for five seconds. We allowed the air to stay in. We radiated it five seconds at first, because we knew nothing of the time limit. We increased the five seconds each day for four days until the time was twenty seconds.

To our surprise and extreme delight, her urine was perfectly sterile culturally as well as microscopically, her bladder symptoms, which had required her getting up eight or ten times at night for a year and a half or more and had resisted everything else, had greatly improved, and she got up only once in the night and could go three hours in the daytime.

We kept on daily, and then later every other day, increasing the doses, until the time was about a minute before I left.

This girl has improved. But once or twice in this month has she gotten up more than once at night. Cystoscopic examination shows a most pronounced healing of the bladder. Immediately after the four radiations there was a general sunburn, you might say, or hyperemia of the whole bladder wall, but her secondary infection showed the most pronounced tendency to recede.

It has been definitely shown that with the ultra-violet rays between 2,400 and 3,100 in the spectrum, it is definitely germicidal, and this case seems to demonstrate that fact.

I bring this to your attention simply because of the fact that it worked so magically in this case. I don't know what its future is

going to be, but I do hope you will try it on these rebellious, stubborn affairs, and let us see to what it will ultimately lead.

Dr. Charles M. McKenna (Chicago): I was indeed very glad to hear what Dr. Thomas had to say in his paper, especially when he emphasized the proper time to operate on the patient suffering with tuberculosis of the kidney. There is so much truth in his paper that in my opinion it behooves all of us to take heed, because Dr. Thomas knows very well from experience that when he operates with a lowered resistance he can expect only a very stormy convalescence, if at all, and usually that type of patient will die with a miliary tuberculosis, tuberculous meningitis, or tuberculous peritonitis.

There seems to be a considerable difference of opinion concerning the treatment of tuberculous epididymitis. Personally I would be inclined to use heliotherapy and sunshine for some time before resorting to surgical intervention. I do not agree with what Dr. Thomas had to say about the comparative lesions of tuberculosis of the genito-urinary tract. I can only quote the work done by Dr. Sweany and myself in 174 postmortem examinations, that 10 per cent had tuberculosis of the kidney, that about 4.2 per cent had tuberculosis of the epididymis, and 2.2 per cent had tuberculosis of the prostate and vesicles. I cannot give those figures exactly, I am trusting to my memory, but I am sure I am safe in saying they are about correct. According to those figures one can easily see that the kidney is involved twice as often as is the epididymis, and tuberculosis of the epididymis about twice as prevalent as is found in the prostate and vesicles. In our own clinic we have operated in a number of cases where the patient was suffering with tuberculosis of the prostate and up to date no evidence of the tuberculosis in the urinary tract has been found, nor any symptoms. Concerning the treatment of tuberculosis of the epididymis, allow me to say that we have seen a number of those cases, and two were shown before the Chicago Urological Society where the patient had multiple fistula coming from the epididymis. They were treated with artificial light and sunshine and apparently made a complete recovery, at least the fistulæ healed and the patients are symptomatically well.

In conclusion, I think Dr. Thomas deserves a great deal of credit for impressing upon us the necessity for further study on

tuberculosis of the genito-urinary tract. I think it shows all of us how necessary it is to have more space devoted to this work in our textbooks in urology. Too little time and too little space are given to this most important work.

DR. F. R. HAGNER (Washington, D. C.): We have had two patients who have had urinary tuberculosis over a long period of time, with apparent involvement of only one kidney.

Both of these patients had healed pulmonary tuberculosis; one of them had had a known tuberculosis of the kidney for six years, and the other patient had had known tuberculosis of the kidney for about four years. The one who had had tuberculosis four years had a little sinus in his side from a tuberculosis of the pleura.

I didn't personally want to operate on either one of these patients. I have had some experience, and it seemed to me those patients who have been known to have tuberculosis of the kidney for a long time do not do well on removal of the kidney. There was no evidence of tuberculosis in the other kidney in either one of these cases.

One of these patients, almost immediately after operation, developed a tuberculosis of the iris. He did not live two months after he was operated on, yet before we touched him, he was doing well.

The other patient has done very badly. He is still alive.

I cannot help but feel that in patients who have had the disease a long period of time, they will do better if we leave them alone, unless there is some absolute reason for operating.

DR. ALEXANDER RANDALL (Philadelphia): I think it is unwise to take the attitude that because a man has a tuberculous epididymis he has to have or does have some renal infection. We have gotten into the habit of looking for medicine to run in a stereotyped line, and when we stop to realize, as we do, that renal tuberculosis is a metastatic disease, we ought to also realize that such metastatic manifestations can occur elsewhere, either as isolated lesions or, as in a certain definite proportion of cases, in conjunction with lesions in other neighboring organs.

In regard to Dr. Hager's presentation, I am glad I read my paper first, because it seems to come along with some very interesting scientific expositions of the problem of the phosphaturia which, of course, plays such an important part in calculus disease.

A few months ago, I happened to stop in at Dr. Newton Richards' laboratory, and I found him bubbling over with enthusiasm for he had just demonstrated to his own satisfaction, by means of a colorimetric test, where glomerular alkaline urine turns acid in its transfer down the urinary excretory passages. It was in one portion of the tubules, and I think we will hear later probably exactly where and why, but apparently he had at last got his finger on that chain which Dr. Hager referred to, as to where the urinary reaction changes in the normal.

Going back, if I may, to the cases I reported two days ago, it has been rather interesting to me to find, in studying pH values in pelvic urine, that they are not, I might almost say as a rule, bilaterally of the same pH value. In my cases there are two outstanding examples.

In Case 1, a stone had been removed from the right side, which side persisted in giving a high alkaline urine, whereas the unoperated or normal left side consistently gave what we might call a normal pH acidity.

The second case simply reversed that whole picture, and where bilateral calculus was present the operated and freed right side came back to normal acidity, while the left side still harboring the calculus persisted in having alkaline reaction.

I think we are oftentimes confused by the metabolists, who get so far away from conditions in their theory on the handling of salts in the body that we are likely to be led astray from simple argument, simple reason, and simple findings. I am quite in sympathy with his conclusions, that in all probability, phosphaturia is a local manifestation of a derangement, rather than a generalized metabolic condition.

Dr. William F. Braasch (Rochester, Minn.): In regard to Dr. Hager's very interesting contribution, I believe that the possibility of a chemical primary phosphaturia being an etiologic factor in the formation of stone must be considered. I believe, however, that the bacteriologic etiology is a more important factor.

It would seem probable that a chemical imbalance is frequently present in the formation of phosphatic stones. This is suggested by several patients we had under observation recently with repeated recurring phosphatic calculi. A marked diminution of citric acid in the urine was found in several of these cases. It is well known

that citric acid in the urine plays an important part in calculus formation, as its presence prevents the calculus formation of phosphatic type and its absence favors it.

We have attempted to overcome the absence of acid in these cases by intravenous administration of large amounts of citric acid, without any effect, however. We have also tried administration of citric acid by mouth.

We are apparently just groping on the threshold of important discoveries in regard to the etiology of renal stone.

DR. H. L. KRETSCHMER (Chicago): I wish to thank Dr. William Thomas for presenting this subject to us in his very illuminating way and for presenting the subject of albuminuria in a new light. The old idea that the kidneys are diseased, and hence eliminate albumin, has been changed by the splendid work he has done. If the albumin "hooks up" with toxic bodies, whatever they may be, the albuminuria is a sort of defensive mechanism, a sort of detoxifying process.

DR. GILBERT J. THOMAS (Minneapolis): I want to thank the gentlemen for discussing my paper.

Dr. Caulk brings up a couple of points. First, as surgeons we are beginning to realize that we must consider tuberculosis as a general disease and not a local one. He mentioned the general health phase of renal tuberculosis and reported that a smaller number of patients had renal tuberculosis during the last year compared with the number of cases of general tuberculosis.

On the question of bladder symptoms, we believe from some experience that patients can be relieved by treating them in bed with rest and general heliotherapy, just as you would any other type of tuberculosis.

Dr. Caulk reported an excellent method he has used to treat bladder tuberculosis. We have used the same method and we have tried with quartz tubes to carry actinic rays directly into the bladder. Quartz tubes are terribly expensive. I happen to work in a sanatorium under the control of the county so that after ruining a couple of these tubes I could not carry on any more because of the expense. We tried radiation of the bladder with actinic rays from lamps through the endoscope. Air will open the bladder thoroughly so that the actinic rays can be thrown directly on the ulcers or inflammatory areas.

In a few patients with bilateral renal tuberculosis associated with severe bladder symptoms we were able to splint the bladder. This was accomplished as follows: A small permanent catheter was put into the bladder and was attached through a rubber tube to an enema can. The enema can is raised above the patient just enough so that the flow of urine from the bladder is not continuous but may flow if the patient coughs and when enough pressure is produced to overcome the height of water in the tube to the enema can. The same apparatus was described ten years ago for the decompression of the bladder. In two cases this worked satisfactorily, because it rested the bladder completely.

Another hopeful method we have for treating bladder tuberculosis is irradiating oil. The oil is irradiated and then it is introduced into the bladder. I do not know how successful it will be.

Dr. Hagner brings up the question of the operation in late cases, five or six years after the patient knew that he had renal tuberculosis. I think it is a question of resistance. How are we going to tell whether a given individual, with a history of renal tuberculosis for six years, has that something that we call defense or resistance? How can we determine that?

We believe that you can find out easily by putting the patient to bed. If he improves his condition, he certainly, from the time we first saw him, did not have as much resistance as he could develop. It is a good time to do a nephrectomy after a patient has been in bed, absolutely quiet, for six months or a year, during which time his condition improves locally and generally. It is better to extend the time in bed before operation rather than after operation.

On the question of the association of tuberculosis of the epididymis, prostate and kidney, we are not sure that our observations are correct. However, during the examination in the last thirty-five cases, except in one instance, we were able to demonstrate tuberculosis in the kidney. This may be just a coincidence. We make this statement for what it is worth.

On the question of tuberculosis in children, we have a hospital containing anywhere from seventy to one hundred children. It is quite remarkable that during the last year I have examined only one child in that group. We are a little bit interested in this because we are paying a lot of attention to childhood tuberculosis.

The reason we are having fewer cases of renal tuberculosis now than heretofore is because we are getting the childhood tuberculosis and curing it or arresting it.

DR. B. H. HAGER (Los Angeles): I wish to thank the gentlemen for the discussion of my paper.

In regard to Dr. Bugbee's question, it may be very difficult to differentiate the infectious from the idiopathic type of chronic phosphaturia. The results of bacteriologic study are not always conclusive and correct evaluation is not certain. This is particularly true in those patients who have been subjected to previous instrumentation where the question of cause and effect is not easily distinguishable.

In the first case which I reported, the urine in the beginning was negative from the standpoint of colon bacilli. We obtained cultures of cocci from the right kidney specimen and from the bladder in only one instance. The other cultures were negative, and we consequently concluded that the presence of cocci in these two instances was probably a result of contamination. After a lapse of twenty-nine months, a passed specimen of urine showed relatively few pus cells in the urine. A culture was not made at this time. Several months afterwards the patient developed respiratory infection as a result of exposure, with associated urinary symptoms. At this time colon bacilli were isolated from both the right and left kidneys as well as from the bladder urine.

I incline to the belief that the phosphaturia was of a non-infectious origin. Whether or not superimposed bacterial infection was responsible for the subsequent stone formation I am unable to say.

CLOSING REMARKS

PRESIDENT KRETSCHMER: One of my most valued possessions is my membership in the American Association of Genito-Urinary Surgeons. I prize it very highly. I have been given the privilege and the honor of serving you in the capacity of president. I feel it has been a great honor.

I wish to thank the members for their generous contributions to the program. I wish to thank the members for the large attendance, considering the general economic depression and the small attendance that is generally manifested now in all of the medical meetings. At the A. M. A. there were only 2,700 members present. I feel, therefore, our attendance here has been very good.

I wish to thank Dr. Sanford for his splendid work and cooperation. Dr. Sanford reminds me of the advertisement that advertises a certain household utility and says, "Make housekeeping easy." Dr. Sanford makes being president very easy.

I think the Society should express to our Canadian members our appreciation of their hospitality, and the splendid entertainment we have had here.

The next thing I would like to do is to introduce to you the next President, Dr. Harry A. Fowler, of Washington.

PRESIDENT-ELECT FOWLER: Speech making is not one of my strong suits, but I will take advantage of this opportunity of thanking the Society and express my appreciation for the honor they have conferred upon me by elevating me to this position. It is indeed an honor to be elevated from a high private in the rear rank to a temporary position as commanding officer.

I would feel some embarrassment, having to succeed to the chair vacated by our distinguished, efficient, and beloved Herman Kretschmer, if I did not have at my left hand our most efficient Secretary, and I feel that, no matter what I may do, the Association will not suffer, because we have such an efficient Secretary to guard and protect our interests. The presidency becomes an honorary position more than one of drudgery and work.

Our next meeting is in Washington. I hope by the time that meeting is held the economic depression from which we are all

suffering will be so far relieved that we will have a very large attendance. The local representatives of the Association in Washington—Dr. Hagner, Dr. Fuller and myself—are going to try to see that all of you who come will have a good time. There will be some restrictions perhaps in certain features, more social than scientific, but I hope that they may be so far overcome that we shall not suffer tremendously in that respect.

I thank you for your courtesy and confidence.

DR. F. R. HAGNER: I think this has been one of the most pleasant meetings we have had. I think it has largely been due to our Secretary, who has handled the meeting in the way he always does, and also to the gentlemen from Canada.

I want to move a rising vote of thanks to our Secretary and also to our distinguished retiring President for the wonderful way in which the meeting has been handled.

PRESIDENT-ELECT FOWLER: The motion needs no second.

The audience arose and applauded.

PRESIDENT-ELECT FOWLER: If there is no further business, the meeting is adjourned.

The forty-fourth annual meeting of the American Association of Genito-Urinary Surgeons adjourned at one twenty-five o'clock.